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MAHARASHTRA STATE GAZETTEERS

सत्यमेव जयते

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BOTANY—PART IV

BOTANY AND FLORA OF MAHARASHTRA

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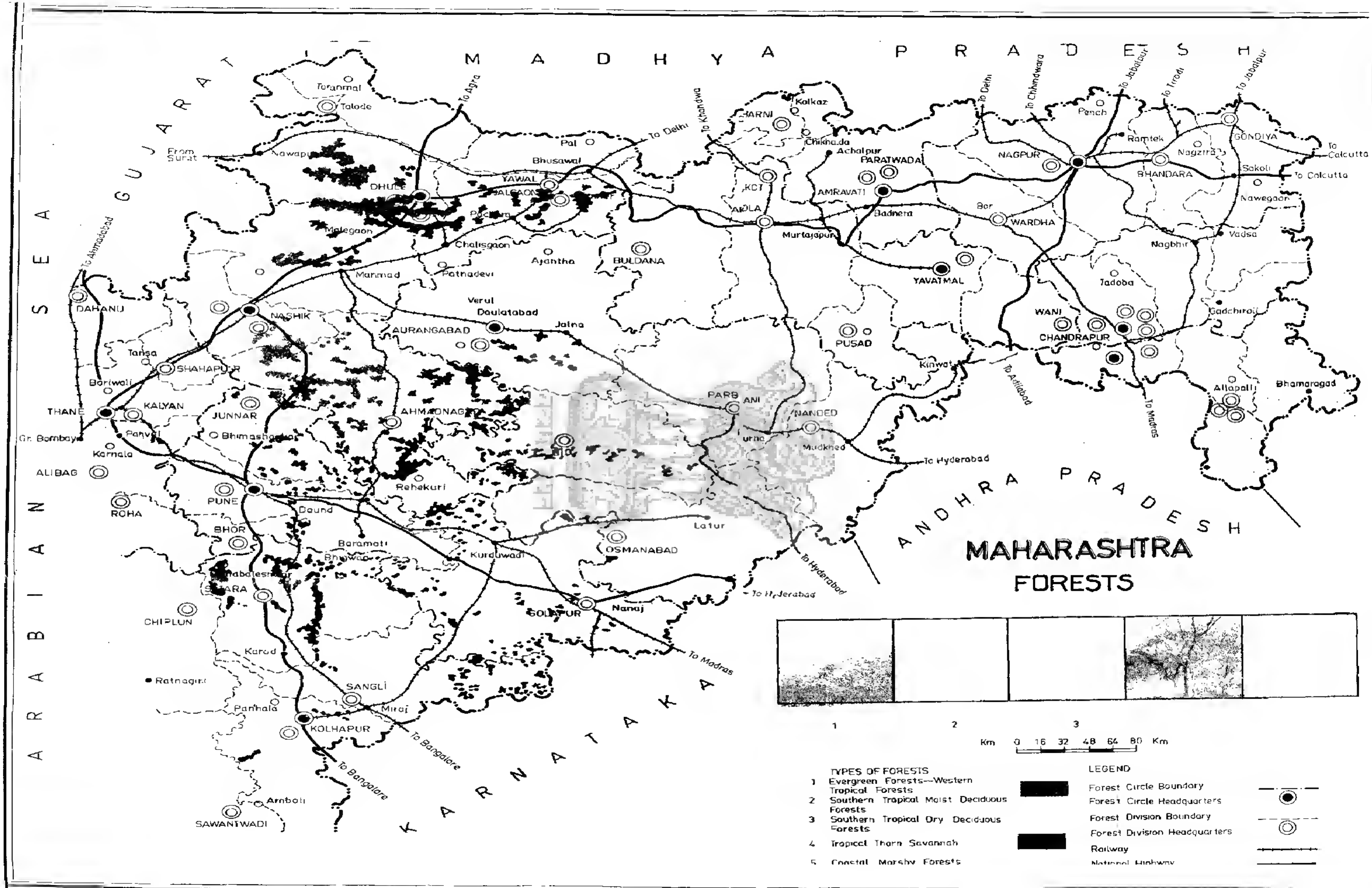
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PREFACE

I have every reason to be glad to present this unique volume entitled *Botany and Flora of Maharashtra* in the General State series of the Gazetteers of Maharashtra. This treatise has been written by the late Dr. T. S. Mahabale, an eminent Botanist of India, as a special assignment by the Gazetteers Department. The volume should have been published during his lifetime. Unfortunately, however, as Destiny had desired it otherwise, Dr. Mahabale completed his worldly sojourn just when he had completed his manuscript. And as Editor of the volume, I had to face an uneviable stupendous task of editing the manuscript on a highly scientific subject which I was ill-equipped to do. I, however, did it as a labour of love, and particularly with a sense of gratitude to the author and the tremendous importance of the subject. I must hasten to add that I am aware of my shortcomings. My job was made easier by Dr. J. G. Vaidya, Lecturer of Botany in the Poona University, who was assigned the work of scrutiny of the matter at the proof stage. I am sure Dr. Vaidya has done justice to this special assignment. I took another precaution by taking the help of Dr. V. S. Pradhan, Professor of Botany, Ruparel College, Bombay, for correcting the proofs at the second proof stage. It is gratifying to note that Dr. Pradhan undertook this laborious work with a friendly gesture at the instance of Shri A. T. Mahabale, son of the late Dr. T. S. Mahabale.

Actually this volume is the Fourth Part of the *Maharashtra State Gazetteer on Botany*. The earlier parts, namely, Part I—Medicinal Plants, published in 1953, Part II—Timbers, published in 1957, and Part III—Miscellaneous Plants, published in 1961, were all contributed by Dr. S. P. Agharkar, one of the most eminent Botanists of India who had a reputation for scholarship even abroad. In the nature of things, these books dealt with the botany of old Bombay Presidency excluding the Vidarbha and Marathwada regions of Maharashtra. Besides, Dr. Agharkar had adopted a different scheme of treatment and classification. We, therefore, decided to bring out a comprehensive volume with an entirely different scheme of treatment and emphasis. I believe this treatise gives a fairly comprehensive and systematic account of the botanical wealth of Maharashtra.

Studies on the plants of Western India date as far back as the third century A. D., the age of *Nighantus*. They mainly dealt with the medicinal plants, their properties and uses as source of drugs, compiled in the works as *Nighantu*. This tradition, however, went into oblivion during the dark days of science in India, and was revived only after the arrival of foreign invaders in India towards the beginning of the 16th century. The Portuguese, the Dutch, the French and the English, who came in succession, initiated botanical studies. A Portuguese physician, Garcia da Orta came to Goa by about 1534. He was a great scholar, physician and philanthropist. Much impressed by the earlier tradition of Ayurvedic medicine and Indian treatises on them, he wrote a book *Os Colloquios* or " Simple Drugs of India ", and got it printed in Goa (1565). This book reached Europe through a Missionary by name El Clusius, and it caught the eye of many physicians, pharmacists and botanists of Europe to the plants of India. Hundred years later, came Heinrich Van Rheede tot Draakenstein, the Military Commander of the

forces of Dutch possessions in India and the Far East. He came to India in 1667 and became friendly with Indians. He secured the help of three Indian physicians to write on the Botany, properties and uses of plants in Malabar area in Western India. By this time, the methodical study of Botany in Europe had greatly advanced from the stage of Herbals to the stage of descriptive systematic Botany through the efforts of Germans. Their tradition of descriptive botany was brought to India by Van Rheede. He got his monumental work *Hortus Indicus Malabaricus* published at Amsterdam in 1678-1703. This was the first formal botanical description, with illustrations of the plants of Western India. It was followed by many botanists such as Graham 1837, Dalzell and Gibson 1851 and Nairne 1861. At the beginning of present century an excellent descriptive account of the plants in Bombay Presidency, was given in *The Flora of the Bombay Presidency* by Theodore Cooke (1901-1908), who was Principal of the Science College at Pune for nearly 20—25 years. His work was incomplete, as the plants of Konkan were not given due consideration. His work was followed up by Blatter, Hallberg, McCann, Fernandes, Molliard, Santapau and many of their associates. Even then, there had been no comprehensive work on the Flora as such, like the *Introductory Essay to the Flora Indica* by Hooker and Thomson (1855) or the *Sketch of the Flora of British India* by Hooker (1904), in the Imperial Gazetteer Series. A short account of the *Botany of Bombay Presidency* was given by W. D. Grey (1885). Volume XXV of the *Gazetteer of Bombay Presidency* was devoted to Botany, and was published in 1886. It contained three articles, namely,—

(1) Useful Plants of the Bombay Presidency by J. C. Lisboa :

(2) Botany of the Bombay Presidency by Surgeon Major W. Grey ; and

(3) List of Gujarat Trees, compiled from materials supplied by G. H. D. Wilson and Lt.-Col. J. C. McRae.

After that there had been numerous publications on some families, individual genera, species, vegetation, etc. But there was no account of plants and flora as a whole on the lines of Hooker or Grey.

Since the above studies were totally out of date, the State Government decided to bring out the Gazetteer on Botany after establishment of the Gazetteers Office. The net outcome was the three books on Medicinal Plants, Timbers and Miscellaneous Plants, written by Dr. Agharkar. But as stated earlier, we decided to publish a more comprehensive and more systematic treatise on the botanical wealth of present Maharashtra. The present volume is a product of these efforts.

The information furnished in this volume is largely based on the works of previous authors who have worked on different groups of plants and on the vegetation of Maharashtra State till about 1980. The views expressed herein, however, are entirely those of the author, Dr. Mahabale. He makes no pretension to exhaustiveness of the study, although his work is unique.

A word about the nomenclature in this book is necessary here. As far as possible the author has not changed the names of plants as given by individual authors in their works, as that would have created confusion in the minds of readers. The corresponding name-changes can be found by interested readers in the works of Dr. H. Santapau, Dr. M. B. Raizada, or in Dr. Saldanha's *Flora of Hassan District* (1976), and others.

The names of genera and species cited here are given with the original author's citation, and that is still considered to be valid. Hence this procedure.

A special attention has been paid to some new topics, such as fossil plants, plants of archaeological sites, fruit trees, and history of Botany and botanists in Maharashtra. Professional scientists and botanists in India and abroad will find this part of the study very useful.

Botany at present is a many-sided science. Several new disciplines are embodied in it. But no special efforts have been made to include all of them here. For example, physiological processes in plants, ecophysiology or cytoembryology have not been dealt with here. That was outside the scope of the present work.

A monumental work like the present Gazetteer requires not merely thorough research and knowledge of the subject, but also deligence and laborious work. It is remarkable that Dr. Mahabale, in spite of his age and ailing health, completed this treatise which has hardly any parallel in India. Born on 19 October 1909, he was the first to secure the Ph. D. Degree in Botany of the Bombay University. Besides four books, he published 134 research papers in well-known journals in India and abroad. He held high positions in various Indian Universities, and in almost all Indian institutions and societies devoted to research in Botany and Flora. He has left the impress of his scholarship in many institutions, but more particularly in the Maharashtra Association for the Cultivation of Science, Pune, the Birbal Sahni Institute of Palaeobotany, Lucknow, and the Indian Botanical Society. Unfortunately death laid his icy hands on him and snatched him away from us on 3 July 1983.

I owe my thanks to the Maharashtra Association for the Cultivation of Science, and particularly to Dr. G. B. Deodikar, Prof. K. R. Surange, Dr. V. D. Vartak, Dr. P. G. Patwardhan, Dr. V. G. Rao, Dr. A. V. Sathe and Dr. V. S. Rao for their kind and generous help to the author. I am specially indebted to the Director of the Botanical Survey of India, Pune, and to Dr. I. M. Qureishi, Chief Conservator of Forests, Maharashtra State, as also to Shri S. A. H. Qureishi and N. H. N. Shaikh of the Forest Department for authentic data, photographs and maps.

I must thank Dr. J. G. Vaidya for scrutiny of the proofs of this volume, which job was specially assigned to him. My thanks are also due to Dr. V. S. Pradhan, who undertook the laborious work of scrutiny of proofs at the second proof stage as a labour of love. The help of Shri A. T. Mahabale and Mrs. Mandakini Mahabale, wife of Dr. T. S. Mahabale, is a great debt which I owe to them.

The present members of the Editorial Board, reconstituted while the volume was under printing, have very kindly encouraged me in this work. To all these men of distinction, mentioned below, I am highly indebted :—

(1) Additional Chief Secretary to the Government of Maharashtra Shri V. T. Chari (Chairman).

(2) Shri P. Setu Madhav Rao.

(3) Dr. C. D. Deshpande.

(4) Dr. U. M. Pathan.

(5) Shri D. B. Karnik.

(6) Prof. Y. S. Mahajan.
(7) Dr. B. L. Bhole.
(8) Shri S. G. Suradkar.
(9) Dr. A. P. Jamkhedkar.
(10) Dr. P. N. Chopra.
(11) Executive Editor and Secretary (Shri K. K. Chaudhari).

I am thankful to Shri R. B. Alva, Director of Government Printing and Stationery ; Shri G. D. Dhond, Deputy Director ; Shri B. B. Bracken, Manager and Sarvashri B. P. Patil and R. B. Prabhudesai, Assistant Managers, Government Press, Nagpur, as also other officers, for the fine printing of this volume. My thanks are also due to Dr. V. N. Gurav, Deputy Editor; Sarvashri S. K. Khilare, P. N. Narkhede and B. M. Kausal (Research Officers) ; and Smt. M. S. Modikhane, Smt. N. S. Alwani, Sarvashri N. R. Patil, K. Z. Raut, D. J. Nawadkar, V. B. Sangrulkar, R. R. Hanwatkar, and V. J. Desai (Assistant Research Officers) for their assistance in the scrutiny of proofs of this volume. I must also thank Shri P. S. Khobrekar, Administrative Officer and other members of the staff for their association with this work.

I hope this cyclopaedic volume will be appreciated and found highly useful by scientists, and scholars in Botany as well as pharmacists and administrators who are interested not merely in the study of the Botany and Flora of Maharashtra, but also desiring to study the botanical wealth of India.

Bombay :
17 February 1987.

K. K. CHAUDHARI,
Executive Editor and Secretary.

BOTANY AND FLORA OF MAHARASHTRA

CHAPTER 1 : ENVIRONMENTAL FACTORS

1. Birth of Maharashtra State

On May 1st, 1960 the present State of Maharashtra was carved out of the then existing bilingual State of Bombay. It is a political entity extending from Bombay to Gadchiroli and Dhule to Sindhudurg districts. It is about 800 km. east-west and 700 km. north-south, an irregular dentate pentagon, lying between 22° 1′-16° 4′ north Latitude and 72° 6′-80° 9′ East Longitude, having an area of 3,07,762 sq. km. It is limited to the west by the Arabian Sea, making a long coastline of 720 km., by Goa and Karnatak to the south, by Andhra Pradesh on the south-east, by Madhya Pradesh on the north, and by Gujarat to its north-west. It forms a large part of Indian Peninsula.

Maharashtra as now formed comprises four regions : Vidarbha or the eastern Maharashtra, Desh or the central plateau of Deccan Peninsula lying to the east of Sahyadri, Marathwada and Konkan, a narrow coastal strip to the west of Sahyadris. There is some geographical diversity in these four regions, but there is also an in-built unity in them due to geographical location and common language of the people, Marathi. The Bhakti cult exercised a great influence by its rich literature on the life and culture of the people for many centuries. Notwithstanding the changing political set-up or boundaries, the in-built unity among the Marathi speaking people has remained intact through centuries in various parts of the State and even beyond, as the Marathi speaking people are not confined to Maharashtra State only.

In a multilingual country like India, it is impossible to avoid overlapping of the people speaking different languages and having different ways of living, especially in the border areas.

What is true of people, is much more true of plants. While studying their distribution, one comes across several instances of over-stepping the political boundaries by family after family of plants, by genera after genera and species after species. One soon comes to realise that the political concept of Maharashtra is not its *bio-geographical* or *geobotanical* concept. Therefore, while studying its plant life, one has to keep one's mind open and study carefully the procession of plant life through the ages in Maharashtra and the surrounding areas.

2. Geographical Situation of Maharashtra

The geographical environment anywhere provides a stage for the life of people and at the same time puts limitations to their activities, aspirations and history. Plants are more dependant on it due to "Fixity of life" which is an overwhelming fact of plant life. Like animals they cannot move from place to place and have necessarily to adjust themselves to their geographical environment and therefore, to get an altruistic picture of plant life in any region, one has to have a good understanding of the environmental factors governing the region.

Maharashtra is essentially a part of Western India. It has a coastline of about 720 km. from Daman to Terekhol Creek. It is only a part of much extensive coast line beginning with Sind, passing through Kutch, Saurashtra, Gujarat, Maharashtra, Goa, Mysore, Malabar or Kerala ending in Tamil Nadu. A rugged line of mountains runs in the north parallel to it and is formed by the outpourings of lava flows from volcanoes active some 70 million years back. Sahyadri is the northern part of the Western Ghats. They extend down south to Muliangiri in Karnatak.

3. Sahyadri Mountains and Passes through them

Sahyadris are flat-topped mountains having a varying height 20—2000 m. above the sea level from Parner fort on Daman-Ganga to Baba Budhan Hills in Mysore through Sawantwadi and Goa. They run north-south and are about 750 km. in Maharashtra. They separate the Desh from narrow coastal strips of Konkan, 50—80 km. broad. It is the widest, about 75—80 km. in Ulhas-Vaitarna valley in Bombay region. There is lush green vegetation in Konkan all round the year due to maritime climate and high humidity throughout the year. But the tops of hills in many places are denuded and without any soil. The extremely rocky regions like Deogad in Konkan look barren in dry months. Desh looks green during and after the monsoons, but gets parched after December—January. The high wall of Sahyadris serves as a barrier for the migration of species on either side. The mountain passes locally called *Ghat* or *Bari,* are useful for traffic, trade and commerce. They are the routes for going from Desh to Konkan and *vice-versa.* Some of these passes are very long, *e.g.*, Bor ghat between Bombay and Pune, Kasara ghat between Bombay and Nasik, Pasarni ghat between Wai and Mahabaleshwar, Phonda ghat between Kolhapur and Goa, Varandha ghat between Bhor and Mahad, Fitzgerald ghat between Mahabaleshwar and Mahad, Amba ghat between Kolhapur and Ratnagiri, and Amboli ghat between Kolhapur, Ajra and Sawantwadi and South Konkan, Malshej ghat between Junnar and Bombay, Melghat in Amravati district overlooked by Gavilgad and Chikaldara etc. One pass crosses the Narmada and enters Madhya Pradesh on way to Indore etc. These ghats are generally very narrow zigzag routes or paths with a scarp or canyon on one side and a valley on the other. They open huge vistas of scenery. Waterfalls, rivulets, rivers and cultivated fields are noticeable from them as they wind their way through mountainous territory. Several metres below underground strata there are reservoirs of water noticeable here and there. Precipitation in the ghat sections and on mountain tops is always heavy. Dense vegetation develops in the valleys. Thickets of stunted trees and bushes grow on mountain tops. In some places near a source of a river or a waterfall, caves are carved out in the brittle multi-layered strata of traps. In some inaccessible corner a small shrine of Shiva peeps out through the forest canopy, or on an isolated odd peak a Bhavani temple raises its head through it with *Bhagwa* flag hoisted on a pole. It is from such places in the ghats that one gets a panoramic view of the vegetation of Maharashtra, especially after the monsoons.

4. River Valley Systems and Sahyadri mountain ranges

The Desh part of Maharashtra is divided naturally into six river valley systems of Narmada,-Tapi,-Purna, Wardha, Vainganga, Godavari, Bhima and Krishna. The three latter are more or less parallel to ranges of Sahyadri mountains on Desh side. They run from west to east diagonally forming four compartments of Maharashtra. Narmada

starting from Amarkantaka in Madhya Pradesh, flows through a very small northern part of our State, enters through Navapur, the alluvial plains of Gujarat and joins Arabian Sea at Broach. The river Vainganga starts from the Satpudas in Madhya Pradesh and flows straight in a southerly direction and then turns east to join the river Godavari at Sironcha. A little earlier the Godavari is joined by the Wardha and the Pranahita. The valley of the Tapi lies on the northern border of Maharashtra. It starts from Multai in Madhya Pradesh and is delimited at south by the Satmala and Ajantha ranges. They constitute uniform system of the Tapi lying to the north of Maharashtra. The Satmala range starts from Saptashringi hills and extends towards Daulatabad, Aurangabad and Manmad. There is a gap in these ranges between Daulatabad, Manmad and Ajantha ranges. This gap has played havoc in the history of Maharashtra, as the Muslim invaders from the north came into Maharashtra through it and thence spread further south. This is the Ajantha-Daulatabad-Ankai gap. The kingdom of the Yadavas of Deogiri (Daulatabad) was destroyed by Allauddin Khilji coming through this gap.

Below this comes the second important range of mountains known as the Balaghat Range. It starts from Harishchandragad in Akola taluka of Ahmednagar district and extends upto Gulburga through Bidar and Osmanabad.

The valley of the Godavari river lies between Satmala-Ajantha range and Balaghat mountain range. The Godavari starts at Tryambak near Nasik and passes to Nasik, Kopargaon, Puntamba in Ahmednagar district and flows further *via* Gangakhed, and Nanded in Marathwada and thence into Andhra Pradesh. It is joined by the Pravara at Toka and by the Wardha and the Pranahita rivers near Sironcha, and that is the boundary between Maharashtra and Andhra Pradesh.

The third mountain range running west-east is known as Shambhu Mahadev mountains. They extend further into Karnatak. The river Krishna arises from the main Sahyadri mountain range at Mahabaleshwar. It is joined by five tributaries also arising in the same range of Sahyadris and passes through Anantpur district in Andhra Pradesh towards Vishakhapattam to join the Bay of Bengal.

An important river running parallel to Krishna is Bhima. It arises at Bhimashankar near Pune and flows through Daund, Pandharpur area and joins Krishna.

The last important river in Maharashtra is the Ghatprabha arising at Amboli in Maharashtra but flows very little in this State and passes into Karnatak territory.

It was observed earlier that the altitude of the Sahyadri ranges becomes less and less as they proceed towards east on the Desh side. The Desh plateau rises by stages from 335—366 metres, 366—610 metres at different places but the major part of Maharashtra is only 91—183 metres high on the Desh side. The highest peaks of the Sahyadris lie near its main axis forming watershed between Desh and Konkan. The altitude drops suddenly to 122 metres on Konkan side and thence almost to sea level. It does not come down by stages as on Desh side but suddenly. Correspondingly rainfall drops abruptly. On the Konkan side rainfall is heavy as the high escarpments of Sahyadris block it. The rivers in Konkan consequently flow very swiftly washing all the soil into sea. They are not extensive nor broad. They get flooded in rainy season and dry up afterwards. Starting from the north of Konkan, one notices rivers Damanganga, Tansa, Vaitarna and Ulhas. These are the larger rivers in Raigad and Thane districts. They provide

main water supply to Bombay city. Damanganga joins the Arabian Sea in Gujarat and is a natural boundary between Maharashtra and Gujarat States.

The next is a group of small rivers in Konkan the principal among them being Amba, Kundalika, Savitri, Shastri and Vasishthi in Thane district, Kajali, Muchkundi, Shuk and Gadnadi in Ratnagiri district. Below that the political boundary of Maharashtra ends with Terekhol river creek. Terekhol river is the boundary between Goa, Karnatak and Maharashtra.

All the Konkan rivers are shallow, flow fast through a narrow strip of the country made up of lateritic plateau having very little soil, with only the exposed rocks. There are no conspicuous dams, water reservoirs or lakes in Konkan as on the Desh side. Scarcity of water after February in summer months is usual in the rural areas of Konkan.

5. Ghats and Mavals

Two conspicuous features in the scenery of Sahyadris are the hill passes, known as *ghats*, and the hill forts built ..ll along the line of Sahyadri in places not easily accessible. There are at least 20—30 major passes or ghats serving as the highways or bye-ways between Konkan and Desh. To reach a place in Konkan one has to cross more than one of them through a wooded mountainous country. Thus between Mahad and Pune there are several major passes such as Fitzgerald ghat, Varandha, Gonya, Ambenali, Tamane, Kumbharli, Katraj, and Diva ghats. Between Bombay and Pune there is the well-known Borghat. Other important ghats are Malshej, Chandwad, Thal ghat etc. As a matter of fact they are everywhere in the Sahyadris as one crosses from one side to the other. Between Pune and Goa there are Phonda, Amboli, Ramghat, Aner, Keljhar, Tina and Kudal ghats. Between Jalgaon and Surat there is Nandurbar ghat. These ghats or mountain passes are often quite narrow and lead from plains at lower altitude to higher mountain plateau and *vice versa*. They are generally in the weak sectors of mountains where the lava flows have been brittle and get easily disintegrated and washed away, than in harder core of the Deccan traps. Very often rivers, brooks, or small streams follow labyrithous path by their side and open into a low altitude basin of a river in the valley. Such valleys are well protected by two mountain spurs running parallel and are fed by mountain streams. They provide unique climate and locations for plants to grow isolated. They are called 'Maval' and are so many. A well-known Marathi poet has put "twelve such Mavals lie below Pune, and twelve below Junnar." They are well-protected uplands,well-drained valleys,well-watered by hill streams They are different from the surrounding areas. Their climate and flora are different. They constitute botanical pockets of considerable interest being upland and isolated from each other and also from the rest of the country below. Hooker and Thomson (1839) have considered them as special sub-provinces or regions botanically and have stressed their importance. Their environment and flora are different. They are something like the *Sholas* in the Nilgiris in South India.

Valleys of Mavals below Junnar are called 'Nere'. The word is derived from the Persian word Nehar, Nehar meaning a tributary or a small river or a canal. Townships developed on them are named after them e.g. Sangamner, Junnar, Parner etc. The great diversity of geomorphological forms, varying from place to place in Sahyadri ranges, produce distinct climatic zones separated from each other by mountain barriers and have different vegetation.

High tops and spurs of the Sahyadris within a forthill also produce a somewhat similar situation in point of flora. Being at high altitude and separated by rocky scarps or artificially constructed fortwalls a similar situation is created.

Humidity in Maval valleys is conducive to the development of moist evergreen types, and to endemism, for example, *Euphorbia acaulis* grows only on the table land at Panchgani. The world famous endemic *Frerea indica* is confined to hill forts of Junnar and Purandar. *Isoetes dixiti* is found in the mountain turns at Panchgani, Panhala etc. Isolation of terrain by mountain ranges has led to endemism. Valleys on Konkan side encourage areca and coconut groves and other plantation crops due to nearness of sea, and high humidity throughout the year. Here the limiting factor is soil not humidity. Small valleys and creeks on the Konkan side produce good orchards and lush green vegetation due to high humidity throughout the year.

Strong hill forts on the peaks and spurs of Sahyadri have been known since the days of Kadambas. The principal among them are Sinhagad, Raigad, Pratapgad, Purandar, Panhala, Harishchandragad, Shivneri, Daulatabad, Songa, Aguada, Fonda etc. In the 15th and earlier centuries defence of the country depended upon the sturdiness of the hill forts. They really were the guardian sentinels of the freedom of Maharashtra since Bahamani rule. In the days of Shivaji, a great care was taken of them being of immense strategic use. Botanically very few of them have been explored, e.g. Purandar, Torna, Sinhagad by Santapau and Vartak. . In their canyans and trenches, ledges and chinks often rare species have been preserved due to their inaccessibility ; otherwise they would have disappeared. Many ferns, liverworts and mosses love to grow on fort walls.

A fourth peculiar habitat of plants in Maharashtra are the sacred groves of trees dedicated to gods, locally known as "Dev Raies". They contain trees and some important economic species. They constitute bits of select vegetation and are the conservatories of past types. Only a few of them have been studied by Gadgil, Vartak, Puri and Mahajan.

6. Two Prominent features in the geomorphology of Maharashtra

Two prominent features in the geomorphology of Maharashtra are the Sahyadri mountain ranges, and the Arabian Sea coast. Some new facts about both these important features have recently been brought out by Koyna earthquake of 1967 and the International Indian Ocean Expedition of 1970. The greater part of Sahyadris lies in Maharashtra (Konkan) and is further extended upto Goa and Muliangiri in Baba Budhan Hills in Karnatak. They have no strike line being volcanic in origin, but only flat uplands along their north-south axis. It becomes somewhat bulged in the middle in Khandesh and runs north-south parallel to sea coast. It has varying width and broad plateaux at various heights. The top most of these receive highest rainfall as they constitute watershed e.g., Bhoma Hills near Khandala, Mahabaleshwar plateau, Tryambakeshwar Hills in Nasik district, Harishchandragad near Kalasubai in Ahmadnagar district. Muliangiri in Karnatak receives nearly 6858 mm. of rain, but it declines sharply eastwards and northwards. There are sharp variations in total rainfall from place to place. This is because the scarp wall of the Sahyadris lies directly in the way of SE monsoon clouds and obstructs them. Heavily water laiden clouds of SE monsoons pour their contents mostly

on the high ranges and plateaus of Sahyadris and only depleted clouds pass over the ranges to Desh. The east side of Sahyadris the Desh thus lies in what they call 'Rain Shadow'. Similarly clouds when they pass northwards the rains become less and less.

But besides Arabian Sea clouds of SE monsoon, there is another route for the clouds, coming from Indian ocean over the Bay of Bengal. There are no hills or mountains in their passage and therefore the NE monsoon current over the Bay of Bengal is mostly uniform. But this current touches only a small eastern part of Maharashtra and hence does not affect most of the tableland or the Desh, as the SE monsoon.

SE monsoon is not uniform throughout the Desh, Madhya Pradesh and Gujarat ; the altitude, local elevations of terrain etc., make difference in local temperature and humidity. Monsoons generally last from 7th June to 10th October. There are on an average 90-100 rainy days. In April and May the Indian continent gets heated up and low pressure zones begin to develop to its north. High pressure winds develop over cool Indian ocean and begin to flow over the heated Asiatic mass. Variable pressure zones are formed over the parts of Maharashtra, Madhya Pradesh and Gujarat. They gather strength by early June and monsoon bursts suddenly starting from Sri Lanka, Kerala and comes over coastal regions of Konkan and thence on the continent. The important features of SE monsoons are as follows :—

(1) They burst suddenly in June and last for about 90-100 days till October 10. The rest of the year is dry, nearly for 8 months.

(2) Humidity is very high 70-90 per cent during monsoons but in the dry period it is low varying from 10-30 per cent.

(3) SE monsoons are not uniform throughout, but are pulsatory in action. It rains for some days and then there is break. Again it rains and stops again for a short while.

(4) They fall at one place but not at another, so that there are comparatively alternate dry and short humid periods of about five days (pentads) everywhere during the monsoons. There is a short break or lull in August all over.

(5) The uncertainty of quantity of precipitation and irregularity of monsoons is proverbial, because the precipitation depends upon the high pressure zones on Arabian Sea and the low pressure zones on the Indian sub-continent, velocity of winds, especially pre-monsoon, altitude, local heating of terrain, nearness to sea etc. The pre-monsoon and late monsoon winds coming from high seas act as trade winds and come over the Arabian Sea on West coast of India. This fact was known to Egyptians, Arabs, and Indian sea-farers and also to the Greek geographer Hippalus about 1,000 years ago before Vasco-da-Gama who is supposed to have found the sea route to India through Cape of Good Hope.

The direction of monsoons first is SW-NE, from June-October, and it gets reversed later NE-SW. They become then the return monsoons. But during their return journey their direction is not always the same as they get scattered and deflected all over Madhya Pradesh, Maharashtra, Gujarat, Uttar Pradesh, Telengana and Marathwada in late August and September. But in addition to SW monsoons there is another monsoon current that comes from the Bay of Bengal and flows over Tamil Nadu, coastal Andhra Pradesh, Orissa, Bengal, Assam, Meghalaya etc. At first it is a feeble current but as the SW current becomes weak, it becomes strong. In some places, the two intermingle.

These two cycles of monsoons are the basis of Kharif and Rabi seasons in India. By October, the Kharif growth season is nearly over and crops are ready for harvesting. In September and in October—November, second monsoon Rabi sowing is in full swing, because the weather in October gets cleared and is both humid and warm. In winter there are rains due to Bay of Bengal current. Thus depending upon rains, humidity and temperature we have two ripening seasons. One reaches a peak of flowering and fruiting in October and the other in March-April on account of the two monsoons' cycles. They have a significant role in the growth of plants and ripening of not only of crops, but of all plants wild and cultivate on Indian subcontinent.

Monsoons also have significant consequences on insect predators such as bees, butterflies and insects. During Kharif monsoon season, bees and butterflies feed on pollen of Kharif crops, but in Rabi season they feed on pollen of crops as well as wild plants. Rabi peak comes in March and lasts longer. Most of the Maharashtra regions especially the western, southern and central are under the influence of Kharif season, whereas Nagpur—Bhandara region is under the spell of NE current favouring Rabi seasons. Naturally crops like cotton, oil-seeds, pulses, *shalu* (winter jowar), wheat which need 120-150 days to ripen, grow better in these regions and early and short seasoned crops like jowar, bajri, nagli niger-seed do better in the Western Maharashtra.

The movement of winds helps the second season or winter monsoons. There are no Sahyadri or other mountains to cross or obstruct their movement. The precipitation is uniform and hence the crops are assured than those of Kharif.

In Rabi season, the humidity is high, and temperatures low and equable, more favourable for plant growth. At the same time, they are also favourable for the growth of plant diseases which naturally affect Rabi crops more than the Kharif ones. On the other hand, heavy rains in Kharif season, especially during anthesis period, are very critical for plant life. They adversely affect pollination, wash the pollen as in Bajri, and thereby prevent fertilization. It also makes way for the advent of plant diseases. Frosts are few. Low temperatures in Rabi season in January-February are highly conducive to the incidence of rust and smuts and for their growth and spread.

An important result of this double peaked growth of plants in two seasonal cycles results in the sudden appearance of the flora of Monsoon Ephemerals which constitutes a spectacular flora of the Peninsular India, in mountainous regions of Maharashtra and sandy areas of Telangana. Thus Sahyadris and Arabian Sea have profound and many fold effects on the entire plant life in Maharashtra.

As a general rule, nearness of sea, local variations and such other factors help to lower the temperature, and low rainfall and humidity tend to produce semi-desert conditions over the Desh region and plains, ultimately leading to scrubby type of vegetation. On the other hand where the rainfall is heavy as in Konkan plain, hilly uplands, Mavals or humid valleys, pockets of evergreen or semi-evergreen vegetations are formed. This process is further helped by the basaltic nature of the rocks of the Sahyadri having good water retaining capacity.

7. The Deccan traps

They are the dark rocks seen all over the Deccan. The word 'Trap' is derived from Swedish word "Trappa", meaning a flight of stairs and can be observed everywhere in Maharashtra. Their steplike appearance

is due to peculiar mode of weathering of trap rocks. As regards the geology of Maharashtra, 90 per cent of it is made up of Deccan Traps. Another important formation is the Gondwanas seen in Bhandara, Chandrapur, Wardha, Wardha-Godavari Pranahita valley and in Konkan. In Konkan small areas around Kanakeshwar at Redi and Jaygad have the Archaeans. These however are only very small areas mostly at the periphery of Maharashtra. The main body of it is made up of the consolidated lava flows poured out at several places by igneous action cooled and consolidated later.

The volcanic action was intermittent. These lava flows must not, have come out as a cataclasm all over at a time but for a long time intermittently. The intervals in between two eruptions must have been long. The Deccan traps have been spread over an area of 38,850 sq. Kilometres on the earlier surface of the earth which was not flat like a table-top but undulated, either Vindhyan, Lametas or Infra-trappean or Gondwanas. The hot fluid lava filled all ups and downs on the ancient surface and the Deccan assumed a shape of flat terraces over terraces. The lava in some parts was brittle and it got weathered and disintegrated earlier, so that step-like form was assumed by the strata, leaving harder core in tact. The present shape of the Deccan traps was moulded by subsequent continuous weathering and wearing.

The Deccan traps occur in very distant places ; at Rajmahendry on east coast in Andhra Pradesh, at Shillong peak in Assam, at Jwalamukhi in Punjab, in the Runn of Cutch (Kala dungar), in Girnar in Saurashtra, at Pavagarh in Gujarat, throughout Maharashtra, Madhya Pradesh and Goa and in northern districts of Karnatak. Their occurrence over vast area from Guna in Uttar Pradesh to Goa in Western India, having varying number of lava flows of different thickness one over the other, cannot be a single event. Rather the whole activity must have been spread over a long time, 70-80 millions of years from the end of Cretaceous to Pleistocene. Throughout this long period, the Deccan was a perpetual burning furnace fuming and steaming after the initial sporadic explosions. The highest volcanic activity was in Maharashtra in the Western region in Khandala ghat area. It continued with a full vigour in early period, got some-what quiescened for some time and again resumed pouring out lava not all at a time or at the same place, but at intervals.

This long and protracted character of volcanic action is evident in many places in Maharashtra in the form of dykes and sills, fossilized water channels, beheaded rivers like Vaitarna, Umred river, etc. Previously geologists used to believe that the Deccan traps were poured out in Cretaceous period. But Professor Birbal Sahni F. R. S. has conclusively proved that the greater part of Deccan traps was poured out in early Tertiary period in Eocene (Sahni 1940). The present opinion however, suggests that they began in a small way at end of Cretaceous, reached a high mark in Eocene, continued with less vigour in Oligocene and again became more active during Miocene at Cuddlore and ended in early Pleistocene.

Professor Sahni (1940) has given a graphic picture of this event in his Presidential Address on "The Deccan Traps" to Indian Science Congress in 1940 at the Madras Session, of which he was a General President. It is as follows :—

"The Deccan lavas, being rich in iron, are of a specially fluid kind that takes long to set. They flow almost like water filling up hollows in the land and spreading rapidly in horizontal sheets, covering miles of country before they harden into the basalt or 'trap' rock that is familiar to us. In its devastating march the 'firey del ge bakes up the soil and consumes all surface vegetation. The very earth is on re.

Pools and trans begin to seethe as the lava flows over them. Here and there a stream is dammed up and collects its waters in a temporary lake till it finds or makes a new channel, or the lake itself is covered up by another eruption. The bigger rivers, not so easily blocked, manage to keep their old course, gradually cutting their way through any lava flows that might cross their path. But the eruptions continue from time to time, and from place to place over an enormous area, originally perhaps half a million square miles, from Rajahmundry to Cutch and from near Dharwar almost as far as Jhansi; piling sheet upon sheet of molten rock and loading the old foundations under a plateau thousands of feet thick. Even after continuous erosion of millions of years the Deccan traps still cover an area of 5,17,998 Sq. Km. and you can travel all the way from Nagpur to Bombay, a distance of 837 Km. without ever stepping off the volcanic rocks. Their abrupt ending along the West coast, where they are thickest and form the great scarp of the Western Ghats, leaves us no real measure of their original extension into the tract of land that foundered into the Arabian Sea.

It is difficult to tell where, in the enormous area of the Deccan traps, this igneous activity first began. The trap of the Nagpur-Chhindwara region were certainly among the earliest to be poured out and so far as we know at present, the highest flow of the series is to be seen on Malabar Hill and at Worli in Bombay. It appears the vulcanicity began in the eastern parts of the Deccan and gradually spread to the west.

The lava flows vary in thickness from a few feet to as much as a hundred. As one flow overlaps another, it seals up the old fissures, and any later eruptions have to force their way up through the entire pile. Theirs is a tremendous outburst. A fresh crack has been rent open, or an old one has split wider. The yawning mouth of Hell roars with thunder, and hurls fire and smoke and ashes miles up into the sky, as if spitting curses on Heaven itself.

The ash comes down again, raining upon the lava still hot round the fissures perhaps raising a mound here and there; or it extends the desolate waste by burying under its weight any fresh vegetation farther afield. Beds of volcanic ash abound in many parts of Western India, specially round Poona and Mahabaleshwar. There must be an eruptive centre in the vicinity.

If a lake or river happens to be nearby, the ash settles down on the water, forming a sort of volcanic sediment in which the creatures living there find a speedy grave.

But it is an immortal grave. For, through a process that is still largely a mystery to us, the bodies of these plants and animals become imperishably preserved. Particle for particle, cell for cell, the plant tissues are replaced by silica derived from the ash, or from a lava flow that may have overwhelmed the lake; and in the end we are left with an exact replica of the original in hard, indestructible silica."

(*Extract from* : Twenty-seventh Indian Science Congress, Madras, 1940. General Presidential Address by B. Sahni, *The Deccan Traps : an Episode of the Tertiary Era. pp.* 7, 8).

8. Geology and Composition of Deccan traps

The Deccan traps are thick bedded piles of consolidated lava flows having a maximum thickness of 3048 metres, along the Bombay coast. This becomes rapidly less towards east and at its southern limit, they are 610-760 metres high. At its extreme eastern limit they become 152 metres. In Cutch in the Anjar area it is 760 metres . At extreme northern limit it dwindles to 30-60 metres . The individual lava flows on an average are 4-5 metres each, and their number varies. For example at Linga Dr. Fox counted 13 flows one over the other. They are separated from each other by a thin parting of ash, scorie, green earth or by beeds of tuff. volcanic ash or other intertrappean sediments. In the lower part of traps such beds are rare. The ash is supposed to have come from local vents and fissures. The traps are mostly arranged in flat layers and very rarely are in the form of cones as one notices at Ankai near Manmad or at Haji Malang near Kalyan. But they are not so uncommon in African traps. The eruption of lava was rather quiet, not violent or explosive, being from fissures. There is plenty of evidence of volcanic action in the whole area. They are generally hori-

zontally disposed but sometimes they have 5° westerly dip. At times they show slight folding of lava sheets in the western parts of the Satpudas in Khandesh and in Rajpipala Hills (South Gujarat), but that is probably secondary, in nature.

The traps are of two kinds depending upon their acidic or basic nature, with all intergrades. When the lava flows are more acidic in nature, they form trachytes, daycites and have yellowish brown or buff colour, rarely a red or pinkish purple. Sometimes they are coarsely crystalline doleritic, vesicular, scoriaceous or amydalodial. The cavities in them are filled with secondary minerals like calcite, quartz, zeolites. They have concoidal fracture. The lava was very fluid, It crystallized rapidly. Thus one sees acid, basic and intermediate varieties of traps. The Girnar traps in Saurashtra, the traps at Pavagarh, those at several places in Bombay Island are acidic and look yellowish brown. For example, the Gateway of India, Institute of Science, Bombay High Court buildings have been built from such acid differentials which are yellowish in colour. They are made up of trachytes, and rhyolites.

The ability of Deccan traps at different places to wear away differs, with the result that throughout the Deccan Trap country one notices various shapes of plateau basalts, made up mostly of fine-grained plagioclase, augite. Magentite is disseminated throughout. The ground mass is dark green or gray in colour. Silts and dykes are plentiful, particularly between Bombay and Pune. Here Agashe and Gupta found 120 dykes in the ghat region. Some dykes occur in the river beds also, or at very high elevation. They are locally known as "KAR". Their importance lies in the fact that they produce weakness in the strata, and when a river bed changes its course, their walls function as bunds. When dykes occur in the river dam area they have to be carefully plugged before impounding water mass ; and special precautions have to be taken by the engineers while constructing dams and reservoirs to avoid weakness in certain spots in the dams, on account of dykes and sills. Chemical composition of Deccan traps is as follows according to Wadia (ch. 10 p. 216)

THE CHEMICAL COMPOSITION OF DECCAN TRAPS

SiO_2	50.61	K_2O+	0.72
Al_2O_3	13.58	H_2O+	1.70
Fe_2O_3	3.19	H_2O-	0.43
FeO	9.92	TiO_2	1.91
MgO	5.46	P_2O_5	0.39
CaO	9.45	Cr_2O_3	none
Na_2O	2.60	MnO	0.16
		Specific gravity ..	100.12
			2.96

(vide Wadia 10-216)

As regards the minerals in them they are generally as follows :—

Quartz	4.14
Ortholasa	4.45
Allite	22.01
Anorthite	23.07
Diopside	17.41
Olivine	..
Magnetite	4.64
Ilmenite, ...	3.65
Abatite	1.01

Occurrence of Titanium oxide TiO^2 in it is very noteworthy and also Ilmenite. They have a tendency to weather spheroidally, following exfloated concentric shells often seen in Khandala ghat or in the ghat between Aurangabad and Chalisgaon. Prismatic joints colamnar structures, steplike perpendicular escarpments are seen a Andheri and other places in Bombay. But more often basalt layers assume the shape of steps of a stair. Such weathering of trap rocks is characteristic of Deccan all over the area. Chalcedony, agate, ash, carneline, jasper, quartz crystals of different colour tints occur in the gas or other cavities in them. Zeolites and other secondary minerals like calcite are common. Rarely asphalt or bitumen also occur as at Dongri in Bombay Island, Malabar and Mazgaon Hill, etc. But by far the most significant features of the Deccan traps are the laterite soils, and intertrappean beds containing fossils. It is not unusual to find only red bole and soil without any fossils, especially in the Middle traps having a depth of about 1220 metres. The stratigraphic sequence of the Deccan traps is as follows :—

Nummulitic Beds of Surat and Broach, Eocene of Cutch laterite unconformity.

Upper Traps 457 metres ..	Bombay and Kathiawar traps. Mere lava flows, contain numerous ash beds. Sedimentary intertrappean beds of Bombay Island contain vertebrate fossils e.g., **Indobatrachus pusillus and Indobatrachus trivialis, Horaclutea, Palaeopristolepis Hydrapsis. Ostracode** and unid shells and very few plant remains.
Middle Traps 4000′ ..	In Malwa, Central India, the lava and ash beds form the thickest part of the series. No fossiliferous intertrappean beds.
Lower Traps 500′ ..	Madhya Pradesh, Narmada basin, Vidarbha etc. Lavas with a few ash beds. Intertrappean beds, many, rich in fossils, both plant and animal.

As the lava erupts and moves in flows, the length and spread of individual flows varies much. In the Lower Traps at Linga in Chhindwara district (M.P.). Dr. Fermor found as many as 13 flows of variable thickness and lengthwise spread one over the other. On the whole they

contain 43—73 per cent Silica Basic and ultrabasic traps contain 45-51 per-cent Silica ; intermediate types contain 51—61 per cent Silica whereas acid types contain over 61 per cent Silica. They show distinct progressive change in composition in their normative value, namely, decrease in quartz, total iron, total water, and in alkali feldspars and Pyroxene. Their composition on the whole however, is nearly the same. Generally it is considered that Bombay and Kathiawar traps are the youngest. Madhya Pradesh and Malwa traps are intermediate and those in Nagpur-Chhindwara area the oldest. But from the view point of flora the inter-trappean beds in the Deccan are important as they contain a number of fossil plants and animals which help to trace the history of climate and vegetation in Deccan.

9. INTERTRAPPEAN BEDS—THEIR EXTINCT FLORA

The Deccan traps are spread over a wide area of 20,00,000 sq. miles from Guna in M. P. to Berar, and from Bombay to Bidar and Gulbarga in Karnatak. There is a sub-terranean junction in Kathiawar and Cutch. Their outliers lie on the east coast at Kateru, Pangide and Rajmundry, Cuddulore and Pondicherry and even at the Shillong peak. They form a continuous mass of igneous crystalline rocks spread in Central and Peninsular India forming part of several States—Madhya Pradesh, Maharashtra, Gujarat, Andhra Pradesh and Karnatak. The energy required to raise such a vast mass must have been tremendous which was probably provided by the radio-active elements in the Womb of Earth. As the highly fluid lava flows cooled over varied earlier surface generally Vindhyan, rarely Archaean, and sometimes intermediate Lametas. At Surat near the village Khoba and Tarkeshwar the upper junction of the traps is reached with Nummulitic beds, occurring as the last part of Tertiary. At Rajmundry they lie above Cretaceous. At Worli hill in Bombay, in Ankaleshwar area in Broach (South Gujarat), in Saurashtra and Kerala they form intertrappean sediments. Due to local variation in the composition of lava flows they form acid or alkaline rocks mostly in the form of plateau basalts basic in nature. At Junagad and Girnar in Saurashtra, one notices acid and alkaline traps and intertraps also.

The volcanic activity bursts suddenly, continues for some time and then lapses into inactivity. After a quiescent period of several years, sometimes hundreds and thousands, to erupt again, there is resurgence of eruption of lava believed to be of the order of 5 million years. In between two quiescent periods soil accumulates between two lava flows, and the process of sedimentation goes on. During volcanic action gases, the steam, ash, hot mud, tufa are thrown out in great quantities and they cover the surrounding areas, burning and killing all plant and animal life around as it happened in Pompei in Italy. At times this amount of ash is so great that sky is overcast and every thing looks dark. Tufa then settles down on water, and gets partially dissolved. It consists of Silicon trioxide (SiO_3) which is partially soluble in hot water. During volcanic eruption water of the lakes and rivers gets warmed up and boils. The volcanic ash gets dissolved in it. Animals and plants die either due to suffocation of gases coming out of creator or fissure or of heat. The dissolved ash and clay in hot water provides slurry for immediate silification of plants, animals, their parts and entombs them. The action is sudden and there is cell to cell diffusion, and particle by particle replacement. They are preserved in an admirable good way. The amount of carbonized matter varies in them and is mixed with sedimentary clay. Sometimes the shallow ponds dry up

and the sediments get heated up like bricks in a kiln due to excessive heat and the burning action of volcano. Thus one finds fine Molluscan shales preserved in silicious mua and clay. Sometimes the organic matter is charred and burned up and only carbon remains in silicious mud and in the form of chalcedony. But it contains no fossils. The sedimentary soil is also completely burned up to form lateritic soil or red bole which is unfossiliferous. Such soils get leached out and form laterite. By further weathering and bacterial action the so-called 'Regur' soil is supposed to have been formed on maturity.

Fossiliferous inter-trappean beds are found at certain places only, where perhaps there was rich vegetation or shallow lake or a river. They are particularly abundant at the periphery of the Deccan Trap country in the Lower traps. Their occurrence in Upper traps is rare and very rare or scarce in the Middle traps. They may even be absent. Wellknown Frog Beds at Worli of Oligocene-Miocene period, Cuddulore and Pondichery series, Upper sandstone series of Rajmundry of the same period are some examples.

From current researches and the fact that in Andhra Pradesh the Deccan Traps are resting on Cretaceous rocks suggest that volcanic activity of Deccan Traps had already started towards the end part of Cretaceous and early Pliocene period and gathered great momentum in Eocene. These are the early traps. The intertraps in Nagpur-Chhindwara, Shivani region seems to be the main focal area where inter-trappean beds are found at many places. They contain chertified material whose preservation is as good as that of Primofilices of Chemnitz in the Province of Bavaria in Germany and better than that of Rhinean cherts of Scotland. The list of plants so far known, is given elsewhere.

To put it briefly about 167 taxa of plant megafossils are known apart from of animal fossils about 25. They throw a good deal of light on the Palaeo-geography, climate, flora and fauna of Deccan then and provoke many problems as they contain such diverse elements as do not exist in India today, but occur in Brazil, Australia, Europe, Baku. etc. They comprise both tropical and temperate species which have provoked controversies as to their origin, distribution and affinities. The last part of Tertiary era also contains some modern general existing in India today, but not necessarily in the present Deccan Trap country suggesting thereby migration of genera and extinction of species.

The most burning question for which no satisfactory answer is yet obtained is the question of Cretaceous Tertiary Boundary *vis-a-vis* the age of the Deccan Traps. The question rather is of the range of volcanicity in the Deccan Trap country, their first occurrence and subsequent spread of the different parts of Sahyadris or the Western Ghats.

Recent oceanographic studies in the Arabian Sea and the Indian Ocean have shown that the west coast of India has been continuous with the wellknown Carlsberg Ridge in Indian Ocean and perhaps further beyond towards the East coast of Africa. This ridge is supposed to have arisen due to the activity of a submarine volcano or a series of them. All these factors have a strong bearing on topography, soils and climate of Maharashtra, apart from the age of the Deccan traps.

10. Climate—General

One of the chief factors that govern the life and distribution of plants is climate. Plants are fixed to the soil on which they stand, and half their story is hidden underground. Their aerial half part is largely affected by atmospheric changes and the underground part by changes in the soil mainly. The fixity of life imposes severe restrictions on the life of plants. Therefore, while delineating the life processes of plants, it becomes necessary to consider first the factors that go to make up the climate and then soil. The soil in its turn is affected by climate. The climate thus has an overall effect on plant life directly as well as indirectly.

The climate comprises temperature, rainfall, humidity, winds and their velocity, rate of evaporation, light or radiations etc. It is customary to differentiate between weather, climate and micro-climate. The term 'weather' is applied to all changes in the atmosphere that take place over a large region, climate to atmospheric changes that occur over stipulated period of time like X'mas, or a week, at a particular place, and micro-climate refers to the zone of air 76·2 to 101·6 mm. to a foot above the surface of soil. It largely affects germination of seeds, development and growth of seedlings, their survival or mortality.

11. The Climate of Indian Sub-continent

The climate of India on the whole is monsoonal and is fairly well stabilized. It is however largely governed by the factors operating outside India and by lands and Oceans that surround it. Similarly the climate of Maharashtra is affected by the climate of States surrounding it and by the Arabian sea and Bay of Bengal. It is therefore necessary at the outset to understand the peculiarities of weather of India of which Maharashtra is an integral part.

The rainfall pattern of India and adjoining countries is also dominated by monsoons. The vegetation, forests, flora, agriculture, water-supply, nay even the life of people, is affected by monsoons. We shall consider them first.

12. The Monsoons and Seasons

The monsoons are a periodic movement of winds originating in Indian Ocean far beyond the Bay of Bengal and Arabian Sea, approximately 20° on both sides of the Equator. They blow more than 6437 kilometres and come in early June with great gusto in South Westerly direction moving a long distance over the sea. They touch India in two streams one coming at the end of summer as south-west monsoon. It crosses Arabian Sea and moves northwards. On reaching Gujarat, it gets deflected eastwards and goes over the Indian subcontinent towards Assam NE. The other current comes over Bay of Bengal and flows over NE or NEE. Both are regular in coming over from Indian Ocean and are considered to be a thermal phenomenon. The SW current touches the West Coast of India in Kerala by about first week of June and moves north-westwards and reaches Bombay by about 7th of June and moves towards south Gujarat. Then it crosses over to the plains of Central India and goes NE right upto Assam through the valleys of Tapi and Narmada. Though they are regular to arrive are rather vague and inconsistent and uneven in distribution. The other current comes late and is dependable.

The effect of regular periodic movement of monsoons has made it possible to recognize the following principal seasons throughout India :

(1) Hot weather season—*Summer.*—March to May.

(2) South-west Monsoon or *Rainy season* or *Varsha Rutu.*—June to September.

(3) Returning Monsoon season, partly wet and parttly dry season from October to November—the *Autumn.*

(4) Cold weather season—Winter from December to February.

These four seasons occur with some variation in different parts of India because the monsoons are never uniform everywhere.

A great uncertainty of rains prevails in different parts of the country affecting crops and subsoil water. There is hardly an year in which famine condition or heavy rains do not occur in some part or the other of India.

13. Climate of Maharashtra

The climate of Maharashtra is also monsoonal. Arabian Sea and the barrier of Sahyadri mountains control it, the former by its cooling effect and the latter by its altitude. The tropic of Cancer lies rightly to its north at 23.5° N Lat. Sun's rays therefore hit earth nearly vertical. Rainfall and humidity in Konkan and hill tops make climate there suitable for certain plants and equable for man. it shows no extremes of either hot or cold as in north. It is equable and suitable in winter for all kinds of crops throughout the year. The real limiting factors for crops are want of adequate rainfall and humidity particularly on the Desh side. Depending upon these eight agro-climatic zones are recognized in Maharashtra.

Generally from the last week of March to first week of May, it is very pleasant in Western Maharashtra. But in Vidarbha it is hot, and like Mediterranean hot and humid in Khandesh. A peculiar type of climate intermediate between that of hill tops and in plains on Desh side prevails in Mavals. It provides very salubrious climate in cities like Pune, Nasik, Kolhapur, Belgaum, Satara. The average rainfall here is not high nor the altitude great, only about 365.76—610 metres. They are also close to sea, and not far from Sahyadris. Humidity is neither low, nor high as in Bombay or Konkan.

The climate of Khandesh and Tapi Valley is very hot in summer, and cold in winter. There is however no drought like that in Solapur, Ahmednagar or Daund region, as the water laiden winds from Arabian Sea flow through the valley of Tapi. Vidarbha has deep black cotton soils. They absorb lot of heat from Sun's radiation during day time in summer months April to June, and emanate it at night. In fact Akola in Vidarbha is one of the hottest places in India, the highest temperature being 120° F. In eastern Vidarbha at Chandrapur, Bhandara and Nagpur the summer climate is dry but temperature range or its duration in day time, are not so high as at Akola. Pre-monsoon showers and thunderstorms are not uncommon.

It will be seen from the above that there is such a variable climate, range of temperature, rainfall, humidity and topography in Maharashtra that different types of plants and crops thrive here.

14. Rainfall Pattern, temperature and Humidity in Maharashtra—

The main form of precipitation in Maharashtra is monsoon. The other forms such a mist or snow are not there. Fog is seen in regions adjoining Belgaum and in the valleys of Khandala, Mahabaleshwar, Melghat in the pre and post-monsoon period early in the morning, when the humidity is high and variation in day and night temperatures is wide. They are generally supposed to be caused by radiational cooling. Squalls accompanying thuderstorms are frequent in Nagpur area. Hail storms for a day or two occur all over Deccan plateau in April and May.

The rainfall is mostly due to south west monsoon and its pattern is very variable in the whole of Deccan Trap country because there is a good deal of variation in temperature during day and night as well as seasonal ones. In the northern part of Maharashtra there is generally a slight tendency towards accentration of maritime climate. The total rainfall, therefore, in different parts of Maharashtra is not uniform. The Konkan and coastal regions get rains regularly about 2540 mm. per year, but much of the water that falls goes to sea due to steep incline of the land. The rocks here, mostly lateriatic, have poor capacity for retaining water. The result is for four months of the rainy season there is incessant rain, and conspicuous absence of if for the rest of the eight months of the year. Despite this, humidity in Konkan never goes below 60 per cent as in Calcutta. On the Desh side it is quite high for four months of the rainy season and low for eight months (October to May). The relative mean humidity is as high as 80 per cent in July-August, but the lowest in March-April, as low as 25 to 30 per cent.

The mean vapour pressure is lowest in January-February about 10-11 mm. and it rises high in monsoon months, the highest being in July. The rate of evaporation is also quite high in this period, it being the highest at Aurangabad, it is lowest during monsoons. At Pune it rises to 15.01 mm. in April and falls to 3.81 mm. in September. At Nagpur it is highest in May, 19.74 mm. and the lowest in December, 4.37 mm.

The highest annual rainfall in Vidarbha is at Dhanora in Chandrapur (1736.00 mm.). At Mahabaleshwar it rises to 6226.3 mm. The lowest rainfall is in Solapur district at Akluj 448.8 mm. This shows how erratic is the pattern of rainfall in Maharashtra. Day temperature and the number of rainy days also show significant differences at different places. The highest number of rainy days is 120—140, and the lowest 25—40. All these extremes lead to vagaries of monsoons and are reflected in the vegetational pattern and flora on the two sides of Sahyadris. On the Konkan side, in valleys, and sunny side of mountains, humidity is generally high throughout year and plants look lust green. The palms, mangroves, wild vines and fruit trees such as mango, nutmeg, chiku, lichi thrive well; despite a few cyclonic and thunderstorms, throughout the coastal areas from Goa to Surat except on the rocky denuded areas such as Deogad. The amount of rainfall, temperature, humidity and evaporation at Ratnagiri, Jaigad, Deogad, Malwan, Vengurla, Dapoli, Bombay, Thane, Karjat, Khandala are quite different. They clearly show a great contrast with those on the Desh side areas. The high level plateaux such as Matheran, Mahabaleshwar, Lonavla Tryambak have relatively high rainfall, but the

vegetation does not look much different from that on the Desh side, as it gets dried up and completely parched in summer months. The natural underground water small reservoirs get dried up and rivers become lean. The vegetation except in the littoral zone is also partially dried.

15. Wind Movements

During the summer months and rainy season (May to October) movement of wind is from sea to land and is from land to sea during winter. Since the wall of Sahyadris lies at right angles to the winds coming over from the Indian ocean northwards, they hit it and get deflected South-West due to rotation of the earth. The Sahyadri ranges obstruct the water laiden clouds as they ascend them. Naturally the rainfall on the top of the Ghat region and in the regions in the immediate vicinity of Sahyadris is high. Thus Mahabaleshwar gets 6200 mm. rainfall and Amboli 7477 mm. The temperature here is low due to their high altitude. Average mean temperature here is 17.7° C in January and rises to 24° C in April. There are no frosts except an occasional thunder shower in winter months and early May. The mountain top and high ranges do not store much water. It gets washed down to the valleys and with it carries the surface soil. The small amount of soil accumulated by disintegration of surface layers of rocks is also removed by winds. The winds are quite strong from sea to land till October and in the latter part of April. The trees on mountain top consequently grow low and stunted e.g. *Syzygium Cumini* grows 9 to 12 metres heigh in plains and valleys, but at Mahabaleshwar on hill tops, it hardly grows 2.4 to 3 metres. The same thing is true of *Alstonia scholaris* growing in valleys on Konkan side and on the top of mountains. It is interesting to note, however that here and there pockets of evergreen vegetation and humid monsoon evergreen forests are formed in the valley and in a few places in the Satpuda range in Melghat at Chikhaldara (Amravati district) and at Khandala in Sahyadris where the vegetation has optimum conditions for growth and the plants well protected. These pockets of evergreen vegetation in Konkan, and in Maval region on Desh side look something like the Shola pockets at higher altitude in Nilgiris. They are generally small belts of about 20 to 30 km. vide, drained by some small river or a stream. They have continental climate, pleasant in winter and cold in summer with moderate rainfall. The temperature variation during day and night not being much e.g. at Ambavade near Bhor the summer temperature is 26°C—29°C and in winter it is 23°C. The rain fall is 1016 mm. Hooker and Thomson (1855) have attached special importance to the Maval region and they consider it to be a separate entity from the floristic point of view.

On the eastern side of Maharashtra—the Desh presents a different picture. It lies in the ' Rain shadow ' region which forms the major part of Western Maharashtra. Here the rainfall in the immediate vicinity of Sahyadri ranges is high, but a few km. further there is a sudden drop. It becomes progressively less and less as the clouds move to the east and north. As they cross the top line of the ghats, they become light and depleted of water and get scattered over the Desh side. They get again heated up by the heat emanating from the earth's surface and their water capacity becomes less and less on their north and eastward movement. The clouds get rarified as they pass on the Desh side, and rainfall becomes low.

A special mention must be made here of the dry belt of Maharashtra where rainfall is the poorest, humidity low, temperature and evaporation rate high. It comprises part of Ahmadnagar, Solapur and Osmanabad districts where famine conditions persist year after year. This is the scarcity zone of Maharashtra. Elsewhere in Maharashtra, on an average the rainfall is 381—508 mm. and average temperature 26°C to 38°C. The difference between day and night temperatures is about 5°C—10°C. So they do not fall in the scarcity area. But in famine zone mentioned above it is just the reverse of this.

In Khandesh, South-West monsoon clouds escape through the valley of Tapi and through the annual mean temperature is high, the rainfall is only 900 to 1000 mm. This is because they get a part of precipitation due to easterly North-East monsoon over the Bay of Bengal and the return monsoons. These are very helpful for Rabi crops in Khandesh.

In the region of Western Vidarbha the temperatures are quite high, the annual mean being more than 40°C. The rainfall is about 975 mm. It also receives some rain due to return monsoons during October and November. The Eastern part of Vidarbha, comprising Chandrapur, Bhandara and Nagpur, gets substantial rains from the Bay of Bengal monsoon current in August to September and even later. The humidity becomes high and temperature low. The rainfall is between 1200—1400 mm. The soils are both sandy and/or black cotton trap soils. They support rich forest vegetation. As a matter of fact Chandrapur and Bhandara districts have the best forests of Maharashtra. The thunderstorms are quite common. In mountainous region and valleys fog is there in winter.

In Khandesh frost is occasional at early morning hours in winter. The water condenses due to drop in night temperature and high humidity. The rate of evaporation in this region is highest between Dhule and Jalgaon and next to that in the region between Nasik and Yeotmal. The water evaporation due to transpiration from forest trees does not make much difference in the humidity on Desh side, as there are no thick forests worth the name, and they are mostly deciduous.

16. Underground Sources of Water in Maharashtra

The other sources of water are the underground aquifers. They have been surveyed in some regions of Maharashtra by Dr. Adyalkar and others (1977). Dr. Adyalkar (1975) found that in Narmada, Tapi and Purna valleys there are a number of regions with fairly good sources of underground water. They occur both in the valleys and also in plains. Their presence is extremely helpful for the supply of water to rivers and wells. Especially they are of much help to summer crops in the alluvial basins.

The quality of water in most places is good. Dr. Adyalkar thinks that there is a good possibility of getting water-supply from aquifers even in the lateritic and red bole soil regions if properly surveyed and tapped. Soil in the intertrappean layers often gets leached and washed out the cavities so formed get filled with water. Thus huge underground water reservoirs are formed in such cavities in Sahyadri mountains, e.g. at Sinhagad, Raigad, Panhala, Purandar Forts standing above 762 metres. The underground water here is sweet and not saline. But it is saline in fountains of Tapi valley, Solapur and Manmad region, and in a narrow belt in Purna valley. For example in the region of Vivra, Rajura,

Javal, Torkheda, Taloda water is saline. There are also underground limebeds, either sedimentary or concretionary in the Wardha and Vainganga valleys. Concretionary limebeds or their patches occur throughout Maharashtra below the black cotton soil at various depths. They are a sure indication of past locus of the sub-soil water in these regions. Hence Dr. Adyalkar has suggested that if there are limebeds below the vesicular trap there is a possibility of getting subsoil water.

The pH of subsoil water is either neutral or slightly alkaline 7.5 to 8. In Narmada basin concentration of Sodium (Na) or Postassium (K) is less than 8 to 9 ppm. Sodium salts (chlorides) are 5 to 10.3 ppm. On the other hand the proportion of potassium and chlorine is higher, 100 to 300 K and Cl 345-1080 ppm. Chlorides in the underground water in the Purna valley basin are still more. The underground water in Tapi valley has 7.2 to 8.5 pH in some places in Jalgaon district. It is sometimes still higher. A few isolated patches of saline water also occur in the valley of Purna river with high percentage of Calcium carbonate ($CaCO_3$) 160 to 451 ppm. The pH of subosil water in the valley of Purna varies from 7 to 8.4 suggesting slight alkalinity. The chloride content varies from 1000 to 5000 ppm. but the percentage of sodium and total solids dissolved is higher. Thus a variable salinity and alkalinity is a general feature of the soils and of subsoil water in Maharashtra. It is not very high, but when the non-carbonate alkali salt is responsible for the primary salinity, or when both get mixed then the water is not useful for irrigation purposes. The sulphates or sulphides are rarely found. Generally shallow waters are good for irrigation rather than deep flowing water from aquifers which have more mineral salts especially chlorides ; and hence they cannot be used for all crops. Because all crops or plants are not resistant to high salt content in soil or water.

17. Temperature

Next to rainfall the most important factor for plant life is temperature. It depends upon the direction of solar radiation, nearness to sea and altitude. There are four distinct regions in Maharashtra on the basis of temperature variation :

1. 95 to 100 F.
2. About 100° F.
3. 105-110° F.
4. 110.120° F.

The lowest temperature is in the coastal region of Konkan from Ratnagiri to Goa, Bombay, and Kosbad due to nearness of sea. Highlands, of Maval region and hill tops also have low temperatures due to altitude. The temperature in the forest zone varies between 86° to 100° F. The places such as Pune. Nasik, Satara, Kolhapur etc. lie in second zone. The third zone is partly humid and partly dry.

There is no snow-fall at any time in Maharashtra and so the sudden cooling of climate is never experienced. However, in winter when cold winds from the north come over from already cold Northern India, then the temperatures in Maharashtra get lowered. The data regarding rainfall and temperature is given in the table No. I-1.

TABLE No. 1-1

RAINFALL AND TEMPERATURE AT DIFFERENT PLACES

RATNAGIRI

Month	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Rainfall mm.	1.8	1·0	0.3	3.6	30.7	709.9	849.9	483.1	333.3	103.9	35.3	4.3	2,61.71
Temp. Max. °C	30.3	29.8	30.6	31.6	32.3	30.3	28.7	28.6	28.8	31.2	32.6	31.4	
Temp. Min. °C	19.5	19.8	22.4	25·0	26.6	25.1	24.4	24.2	23.7	23.6	21.7	20.1	

GREATR BOMBAY

Month	J	E	M	A	M	J	J	A	S	O	N	D	Annual
Rainfall mm.	3.6	1.7	1.1	2.0	17.8	470.4	669.7	371.9	290.9	70.1	16.6	1.5	1,917.3
Temp. Max. °C	28.5	28.6	30.3	31.8	32.9	31.5	29.7	29.5	21.8	81.6	31.6	30.4	
Temp. Min. °C	19.3	19.8	22.2	24.6	26.5	26.0	24.9	24.6	24.3	24.3	22.9	20.5	

PUNE

Month	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Rainfall mm.	1.9	0.3	3.1	17.6	34.7	102.8	186.8	106.4	127.3	1.9	37.0	2.0	624.7
Temp. Max. °C	30.3	32.5	36.5	38·3	38.2	31.9	28.5	27.6	29.2	31.9	30.27	29.4	..
Temp. Min. °C	11.6	12.8	16.5	20.1	22.4	23.5	22.5	21.4	20.5	19.5	14.6	11.6	..

NASIK

Month	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Rainfall mm.	4.3	1.7	1.7	5.4	18.6	158.3	341.4	227.5	184.0	59.1	28.0	4.5	1,034.5
Temp. Max. °C	28.4	29.9	34.7	36.2	37.4	32.7	27.7	27.6	28.3	31.6	30.4	28.3	..
Temp. Min. °C	10.1	11.3	15.0	18.9	21.5	22.8	21.8	20.9	19.7	17.7	13.2	10.2	..

AHMADNAGAR

Month	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Rainfall mm.	7.1	1.5	4.1	10.7	20.8	128.3	97.5	73.7	175.5	57.7	36.1	8.9	621.9
Temp. Max. °C	29.2	31.4	35.3	38.0	38.0	38.9	33.6	29.6	30.0	31.4	29.6	28.9	..
Temp. Min. °C	11.9	13.4	17.4	21.1	22.4	22.3	21.5	20.7	20.0	18.7	14.7	11.7	..

AURANGABAD

Month	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Rainfall mm.	7.4	24.3	4.1	5.8	16.8	134.1	173.5	122.89	107.2	47.0	31.0	8.9	725.8
Temp. Max. °C	29.3	31.4	35.6	38.6	39.8	34.6	29.9	29.4	30.0	32.0	30.2	28.7	..
Temp. Min. °C	13.8	15.4	19.6	23.3	24.4	22.9	21.6	20.9	20.7	19.4	15.8	13.3	..

TABLE No. I.1—*contd*.

AKOLA

Month	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Rainfall mm. ..	10.7	10.4	7.9	4.1	10.7	135.6	237.5	159.8	151.9	37.3	23.4	11.2	800.5
Temp. Max. °C	30.1	32.5	37.2	40.8	42.4	37.3	31.7	30.8	31.8	33.6	31.1	29.3	..
Temp. Min. °C	12.9	14.4	18.9	23.9	27.5	25.8	23.7	23.2	22.8	19.4	14.7	11.9	..

NAGPUR

Month	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Rainfall mm.	11.4	23.4	16.8	16.3	20.8	222.0	376.2	286.3	184.7	154.6	19.8	9.9	1,242.2
Temp. Max. °C	28.7	31.2	35.9	40.3	42.7	37.6	31.2	30.7	32.1	32.8	29.8	27.7	..
Temp. Min. °C	14.3	16.6	20.7	25.1	28.3	26.4	24.2	23.9	23.7	20.6	16.5	14.4	..

CHANDRAPUR

Month	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Rainfall mm.	7.6	24.9	14.7	19.6	13.7	194.6	392.9	308.1	215.4	56.4	15.7	3.8	1,267.4
Temp Max. °C	29.6	32.3	37.1	40.7	43.0	37.6	31.2	30.7	31.6	32.1	29.6	28.2	..
Temp Min. °C	13.2	15.3	19.5	24.4	27.9	26.6	24.3	24.0	23.6	20.1	15.1	11.6	..

GENERAL COMMENTS ON THE CLIMATE OF MAHARASHTRA.

In the topography of Maharashtra as delincated above, the wall of Sahyadris acts like backbone; vast watery expanse of Arabian Sea to the west, and equally open higher level plateau on the east towards Desh-side give rise to many local variations of temperature, rainfall, humidity etc. They produce more local effects on the climate, rather than on the generalised climate of Maharashtra, as there is much local variation in respect of these factors in Maharashtra.

There are a few hill stations in Maharashtra. They have different climate than that in the plains. They have equable climate. All through Maharashtra sunshine is bright but the humidity is low. The vegetal cover is poor. The climate however, does not show extreme variations. One notices dry deciduous forests at Chikhalda, Toranmal, Ajanta and everywhere on plateaus of Desh and moist deciduous forests at Khandala, Mahabaleshwar and in the valleys of Desh. The trees turn completely yellow and dry up in summer months, but produce new foliage as soon as the humidity goes up in May.

Both in summer and rainy seasons some plants sprout and produce flowers and others produce new foliage. With the advent of monsoons the dried up trees and herbs bloom again and present fresh appearance in rainy season. As a matter of fact a special feature of the flora of Maharashtra is the sudden appearance of the Monsoon ephemeral flora on the Desh-side and in Ghats, which will be discussed later, Broadly speaking rhythms of growth and flowering in Maharashtra are tuned to the periodic rainfall and temperature. There is a short flowering season in October and a long one from February-March to late May. Latter is the major flowering season in Maharashtra and the former for the herbaceous and underground tuberous plants. Their life span is short.

18. ARABIAN SEA

Like Sahyadris another important physical factor which influences the climate, vegetation, forests, crops etc. of Maharashtra is the presence of the Arabian sea, almost parallel to the coastline of Western India. It creates weather conditions that affect Antartica. Australia, Asia and Africa. Two most significant events connected with it are : the monsoons and rifting of continents in the Southern Hemisphere. Meteorologists, geologists, palaeobotanists and plant geographers have been studying several problems connected with it.

It is well-known that monsoons cross over Peninsular India in two streams : (1) The South-West current touching west coast crossing Sri Lanka, tip of the Southern India, Kerala, Konkan, and then Maharashtra, Gujarat, Madhya Pradesh, (2) Another current NE monsoon crosses over the Bay of Bengal, reaching Assam and West Coast of Burma. Both the streams get intermingled in North India in the Sub-Himalayan region. There are different pressure zones in Northern India and on Bay of Bengal which create cyclonic storms over an area 10°-15° North of Equator where some high pressure zones arise and move towards Bengal and Bangala Desh playing havoc with the coast line and islands nearly, inundating and submerging them. No such heavy storms are known due to South-West monsoons.

The whole of Konkan area is strewn with small shallow rivers and swift streams. They also get silted up at their mouth and form estuarain beds of loose detritus or littoral concrete. Their banks get filled with mud years after years and local people put bunds across them and

build excellent fertile soil for cultivation of paddy, vegetables, orchards of coconut and areca, fruit trees like mango, cashew and *kokam* or Garcinia. These lands get periodically inundated by seal water in high tide and salt is deposited on them. Sometimes it is a heavy deposition and land becomes uncultivable (Kharland). But should there be some source of fresh water on the surface or underground, the salt gets leached out and pockets of evergreen vegetation and excellent fields growing certain varieties of rice like '*kala Rata*' thrive on them. The same thing happens in monsoons. Good vegetables, beans and other plants tolerant of more salt content grow well there. In fact rice is grown twice here as in Goa.

They ultimately lead to mangrove and strand forests. Under somewhat similar conditions in Europe and Africa all along the mediterranean sea coast oil palm, *Elaeis guineensis* is cultivated. It yields oil which is used in the manufacture of margarine, red oil soap, vitamins etc. No such attempts have been made here despite very favourable conditions for the plantation of oil palm.

Geologists believe that Western coast of India has been submerged at least 3-4 times in the course of the evalution of the Arbian Sea. As a matter of fact there are quite a few places on the West coast of India where the ancient coastline lies high above the present sea level. For example, lignite beds occur at 18-24 metres high above the present sea level at Ratnagiri. Similar beds occur above the sea level at Worli, Dongri and Madh in Bombay, near Chiplun at the mouth of the Vasishthi river. Hot water springs are also found at many places e.g., near Vasai at Vajreshwari, Mahad and Sangameshwar. In some places the sea is quite deep forming rich pastures of food for fish, shrimps and cray fish near Deogad, Malvan, Vengurla and Vasai (Bassein). In some of these places oil has been found now.

The form of continental shelf is also different at different places on West coast, e.g., at Veraval, Ghoga, Bombay, Ratnagiri, Vengurla, Goa, Cochin, etc. The peat beds are also known. At Vasai, and Bombay High a rich source of oil is found and is being exploited. Some more are expected.

But apart from economic, strategic and commercial considerations the Arabian sea is now known to have some biological peculiarities of its own. They have been brought out by Sir Seymur Sewell oceanographic expeditions of 1919 and by the recent International Expedition of Indian Ocean in 1965-66. They are :—

(1) The temperature of sea-water of upper layers of Arabian sea in winter is warm and in summer it is cool, because a deep flowing stream of warm water, some km wide, flows from the East coast of Africa from near Madagaskar and Somalia to the West coast of India. It closely follows the coast line of Arabia, Persia, Pakistan and thence Saurashtra, Gujarat, Maharashtra down to Kerala and Cape Comorin. This is known as Somalia current, and it help to keep the thermal equilibrium of water in Arabian sea.

(2) Cyclones due to south-west monsoons are rare. The one that occurred in November 1948 had velocity of 128 kilometres per hour at Bombay. But such ones are very rare. They play havoc with trees which have shallow root system and get easily uprooted almost instantaneously. Nearly 90 per cent of the tall trees in the Fort area of Bombay fell that time in November 1948.

(3) Arabian sea has a moderating influence on the climate of Maharashtra.

(4) It is well-known that Portuguese Captain Vasco-da-Gama reached India with late monsoon winds which brought his ships to Calicut. This fact was known to early Greek navigators like Hipaulus. If a line from Madagaskar, Maldiv and Lakshadweep Islands is drawn, there are a number of small islands on it in between Africa and India framing a sort of Monkey or Lemurian Bridge. This bridge is supposed to have enabled the distribution of plants from Africa to Madagaskar to India nad *vice versa.* Thus there are some plants common to the West coast of India and East coast of Africa, Madagaskar, etc.

(5) Sir Seymur Sewell who made oceanographic study of Arabian Sea and Indian Ocean, found that water of Arabian sea gets circulated coast to coast and that there is a submerged mountain ridge in Indian ocean known as Karlsburg Ridge. It is probably volcanic in origin and has basaltic rocks on its top similar to those of Sahyadris.

(6) Salinity of water in Arabian sea varies between 3 per cent to 5 per cent in different seasons of the year. Sea water is rich in food material for sea animals and plankton at places, *e.g.*, near Malvan, Vengurla, etc.

(7) There are excellent mangrove forests on the West coast of India. Their peculiarities are discussed in the Chapter on Mangroves and their ecology.

19. Soils of Maharashtra

Most of the soils in Maharashtra are formed from the Deccan Traps generally from the augite or amygdalodial basalt. These soils are black, dark brown or reddish in colour, and hence are called Black Cotton Soils, or ' *Regur* ' soils meaning thereby red soils. Some soils in Nagpur, Bhandara and Chandrapur districts are derived from Vindhyan and Goandwana formations. They form small areas of sandy or loamy soils in Bhandara, Chandrapur and in small pockets in Ratnagiri district near Redi and Sawantwadi. But on the whole they form a very small proportion of Maharashtra soils.

Black cotton soils are heavy in texture and have high percentage of clay. As such they are sticky and plastic. They swell on wetting and shrink on drying. They have adequate proportions of mineral nutrients and also micronutrients, hence they are considered good for plant nutrition. Some times they are slightly alkaline; but they are poor in humus or nitrogen. Morphologically and genetically they are similar to the black soils of South Africa, Australia and Charnozem soils of U. S. S. R. They constitute a group of black soils called' Grummusel ' soils spread in the tropics and subtropics of the world. They may be deep or light. Generally such soils derived from trap are deep; but when they are derived from granite or gneiss they are light and yellowish. The dark colour of the trap soils is due to clay fraction and is responsible for their sticky nature. The base exchange capacity of black soils is higher than that of red soils. Their water holding capacity and air dry moisture are also higher. The water retaining capacity decreases with the higher percentage of clay and increases with the percentage of humus. Because of this they do not get easily eroded, but loose water due to cracks and evaporation. According to well-known soil chemists Basu and Sirur their black colour is more related to their moisture content and inorganic substances in them than to the organic matter present in them in small proportion. Generally deep black cotton soils are not formed at high altitude of mountains. They have been matured under the long monsoonic climate in the past as at present, with its alternation of periods of short humidity and a long

period of aridity. They are one of the oldest group of soils since the Tertiary era. The temperature of the region in which they occur varies from 12°—14°C minimum and 40°—42°C maximum. The rainfall is 381—762 mm. on an average. They support dry deciduous forests or a Thorn Savannah.

In point of chemical composition they contain alumina, siliceous acid, some form of manganese oxide and dehydrated oxides of iron and calcium. Besides Maharashtra, they occur throughout the Deccan Trap country in Madhya Pradesh, Gujarat, Mysore, Andhra Pradesh and even in Rajasthan. Their clay percentage varies from 40—60 and may be slightly lower or higher. Their structure is cloddy or some times crumby with aggregates having natural cleavages. They have 10 per cent coarse clay, 20—25 per cent fine clay and 60 per cent superfine clay. They have about 10 per cent porosity, and 3—7 per cent hygroscopic moisture. The pH varies beween 7-8.5, they being generally slightly calcarious or alkaline. The amount of calcium carbonate is moderate. The black colour as already remarked is due to the presence of inorganic substances and moisture rather than due to organic matter like humus. The predominent base comprises saturating clay complex in calcium along with a small amount of magnesium. Calcium magnesium ratio is more in the upper layers of soils and decreases with depth. In some places 0.0—0.53 per cent manganese occurs in them. Boron is also prsent in small quantities. The main constituents of black cotton soils show high variation in different areas. Below black soil on the Desh side there is generally ' Murum ' mixed some times with lime or *kankar*, or salt, or salinized lime and gypsum. There is no such murum under lateritic soils in Konkan. One can see all stages of laterization and ripening of soils at various stages in the Ghat sections and below them. Black cotton soils being argillaceous have a fair proportion of calcium, potasium, chloride, alumina etc. They are either neutral or slightly alkaline. Magnesium is also present in the form of carbonate. The proportion of lime is some times as high as 4.5 to 6.2 and phosphoric acid 0.01-0.03 per cent. Potasium is 0.13—0.19 per cent. These soils, if fed with sufficient water and Nitrogen, are capable of high productivity, particularly of cash crops like sugarcane, chillis, groundnut, jowar, wheat etc. In some areas on banks of Purna and Vainganga rivers, some areas of soils are saline or ' chopan ' or ' usar ' (calcareous), but the rest are under black cotton soil.

In the high temperature areas of Deccan Trap country sub-soil water comes to surfaces rapidly and salt accumulates on the surfaces; or it remains at a certain depth in the soil as was shown by Basu and Tagare. In low lying areas the salts get deposited permanently. As a result of evaporation, sodium chloride gets deposited either on the surface or at the bottom of the low areas and gets more and more concentrated. Due to increase in the salt content sodium and chloride ions accumulate on the surface or at the bottom. Salination tends to alkalization and the soils become saline. Salination is only one step earlier towards alkalization. Both are harmful to plant growth and affect the yield and lower productivity. In such soils sodium chloride accumulates in a definite zone in soil and the root system of plants, especially of crop like cotton, get damaged by the sodiumized layer. To avoid this, chemical, agronomic and biological methods are used; also they are drained by digging trenches in such saline soils for reclaiming. 37,586 hectares (83,000 acres) of soil in Maharashtra is damaged due to salinity and about 38,395 hectares (85,000 acres) due to alkalinity.

Naturally saline soils occur in the Khar-land zone close to sea coast, apart from the areas constantly irrigated by the Deccan canal system where excessive doses of fertilizers are used. Khar-land soil becomes saline due to periodic innundation by sea water. Khar-lands lead to mangrove soils which are quite rich in salt content and also calcium. They form an important belt of vegetation along the sea coast. The process of salinization and alkalization is as follows :—

$CaCO_3$—$_2Na$—clay—Ca—clay—Na_2CO_3

Clay Complex—Soluble Na salts—Alkali salts—Salts of other bases like Mg.

Ca			Na	
Clay	Ca—Na—Cl—Na	Base	Clay	$CaCl_2$
Complex		Exchange	Complex	
K	$+MgCl_2$—KCl		Na	

Some soils are both saline and alkaline, Should these saline soils be properly flooded with fresh water, salts get leached out and become progressively desalined. Some varieties of paddy or vegetables grow well on them. Addition of gypsum and suitable fertilizers help to recover them; otherwise they become more and more infertile due to increasing salinity.

The black cotton soils in scarcity zone of Ahmadnagar, Solapur, Jalna, Beed and Aurangabad districts are saline and infertile, Due to high temperature and low rainfall they become unproductive. But in some years when the rains are heavy they produce bumper crops.

In some places there are yellow soils of fossil origin belonging to Miocene period. There are friable soils also of the pleistocene period. They are dark and peaty. These are of course rare.

Distribution of soil zones

Next to climatic factors the climax vegetation of a place is determined by soil or edaphic factors. The natural distribution of plant communities depends primarily on climate and secondarily on soil complex, Nine major agro-climatic zones have been recognized (see map). They are along the Western side of Sahyadri (4) and (5) along the Desh side They are :—

(1) Mangrove belt,

(2) Lateritic soils of Konkan,

(3) Transitional soils adjacent to ghats on Konkan side,

(4) Soils in ghat region having high rainfall,

(5) Soils in the immediate vicinity of Sahyadris tolerant of high rainfall,

(6) Soils of Maval region,

(7) Soils in the plains with moderate rainfall,

(8) Soils in the scarcity zone, and

(9) Soils in high rainfall region and having mixed soils.

The transitional zone (3) on the Konkan side in the immediate vicinity of Sahyadris is not very broad. It supports poor crops, cereals like *Elucine, Rala, Niger*. The transitional zone on Desh side is some times divided into 2 parts;

1. Light brown soils tolerant of heavy rainfall and higher attitude such as those in Maval and Dangs regions.

2. Deep soils tolerant of heavy rainfall, distributed on plains having a low gradient 0.914—1.219 metres per mile. This zone is small and mostly the one where paddy is cultivated. Its major portion lies in Kolhapur, Satara, Pune and Nasik districts. Then comes the major crop producing zone of Maharashtra. It has assured moderate rainfall and plain surface extending about 400 miles long and 250 miles broad. The rainfall is about 508—635 mm and regular. Next to it there is a zone of soils either loamy or alluvial along the courses of rivers Godavari, Bhima, Krishna, Sina. Here the rainfall is about 508—635 mm (20″—25″) and surface is flat, temperature high, soils deep and fertile. All these conditions are suitable for the growth of cotton and jowar. It produces best long staple cotton and high yield of jowar e.g. the Parbhani, Nanded in Marathwada area and Khamgaon in Vidarbha.

The soil situation in Khandesh and Vidarbha is different. The river Tapi descending from the ghats in Madhya Pradesh into Maharashtra has rich black cotton soil and supports all other crops in Khandesh. Tapi breaks the continuity of Sahyadris and passes into Gujarat in Navapur taluka to Ukai where a high level dam is constructed. The soils in Khandesh, therefore, are extremely fertile and have ideal conditions for cotton, bananas, sugarcane, groundnut and such other each crops.

The Vidarbha soils are formed by the Archaeans, the Vindhyans, the Gondwanas and the Traps. Vainganga, Purna and Pranahita rivers drain them. They, get both South-west as well as North-east monsoon rainfall. They, therefore, support rich monsoon forests in Melghat and Chikhaldara areas in Amravati district and Allapali forests in Chandrapur district. The Vindhyan soils of Nagpur and Bhandara districts lie in the valley of the Vainganga. They have a fair amount of calcium either as nodules (*kankar*), or in layers, that reduces the salinity of soils there, and helps to produce jowar and other crops. However, in areas where either salt or calcium occur in large proportion they become harmful to plant growth.

It will be seen from the above that a variety of rainfall pattern, climate and a variety of soils exists in Maharashtra. Due to them, all kind of horticultural and agricultural crops are produced and the teak forests especially in Pune, Thane, Nasik, Buldhana, Amravati and Chandrapur districts. The last one has conspicuous teak forests much prized for the figured timber of teak.

Physico-chemical characteristics of soils in Maharashtra State, and their fertility are fully dealt with in Agriculture Department Research Bull No. 21, Soil Conservation Series 9 and are given here (*See* Table No. I-2). Briefly stated they are as follows :—

1. The more important characteristics of soils from the view point of plant growth as the presence of major nutrients, micro-nutrients water retaining capacity and drainage, absence of salinity, alkalinity

or acidity. Most of the soils in the State are derived from the Trap except the ones in the coastal areas and in Bhandara and Chandrapur districts. The latter are derived from seaside alluvium, and in case of the former from mixed parent rocks in Bhandara district. The coastal saline soils gradually merge in the coastal alluvium wherever present. The topography largely influences their development.

2. *Lateritic, Red bole and laterite soils.*—These occur in the eastern part of Chandrapur district and have been developed under the warm humid climate under plenty of forest vegetal cover.

3. *Coarse hill slope soils and clayey loam in the valleys.*—These occur at high altitude on the mountain tops and hill slopes. They are clayey in texture or loamy. Mostly rice grows in them.

4. *Deep and medium black cotton soils derived from Trap.*—They cover the largest area of Maharashtra. They are uniform and more or less neutral or slightly alkaline in reaction. They are light, heavy or medium. There is not much difference in the surface and lower layers. They are present in Bhima, Krishna, Sina and Godavari valleys. They contain extremely favourable plant growth substances and are good for crops.

5. *Coarse gravelly soils.*—These are found in western part of Chandrapur district. They are a barad soils, very coarse in texture and have poor fertility. Only small millets grow on them.

6. *Shallow clay loam soils.*—70 per cent of the area in Bhandara district have these. They are derived from mixed parent rock materials. They are medium and have mixed origin. Rice and wheat grow on them.

7. *Saline and alkaline soils.*—These are present throughout the State where the drainage is poor, and where canal water or sea water innundate them. They are found in highly irrigated areas e.g. under Nira Canal and in the coastal area known as *khar lands.* Later they develop into saline soils or acid or alkaline soils.

Most of the soils in Maharashtra State contain good plant nutrients and also micro-nutrients except a few which lack manaegnese. zinc, molybdenum; but in point of NPK they are very good and by addition of corrective fertilisers and nitrogen give bumper crops. They generally have pH about 7. As examples of typical soil contents. analysis of some is given in Table No. I-3. They illustrate nature of typical soils in different regions of the State.

TABLE

CHARACTERISTICS OF SOME

Description (1)	Medium Black Soil (2)	Deep Black Soil (3)	Lateritic Soil (4)
Location ..	.. All districts of Deccan and Marathwada and western districts of Vidarbha.	Along the banks of rivers and streams in the Trap area.	Southern part of Ratnagiri and northern part of Satara and western parts of Sangli and Kolhapur.
Parent Material ..	.. Trap ..	.. Trap ..	.. Laterite and Trap
Climate	.. Arid ..	.. Arid ..	.. Semi-humid ..
Rainfall in mm. ..	.. 635-762 ..	.. 635-762	.. 1905-3810 ..
Vegetation ..	.. Grass ..	.. Grass ..	.. Forest .. ..
Topography ..	.. Undulating	.. Flat ..	.. Hilly to undulating
Depth in metres ..	.. 1 to 1.5 ..	.. More than 1.5	1 to 1.5 .. ..
Texture	.. Clay loam	.. Clay ..	.. Clay loam ..
Colour	.. Greyish-black	.. Black ..	.. Brownish red ..
Nitrogen (mgm) 100 gs.	.. 40-50 ..	.. 50-90 ..	.. 150-200 (per cent)
C. N. Ratio ..	.. 12-15 ..	.. 15-20 ..	.. 10-15 .. ..
Hcl. Soluble P_2O_5 (mgm)/100 gs.	.. 60-100 ..	.. 80-120 ..	.. 50-80 .. ..
Hcl. Soluble K_2O (mgm)/100 gs.	.. 150-300 ..	.. 200-400	.. 80-100 .. ..
Available P_2O_5 (mgm)/100 gs.	.. 10-15 ..	.. 15-20 ..	.. Traces .. ..
Available K_2O (mgm)/100 gs.	.. 15-20 ..	.. 20-25 ..	.. Traces .. ..
Lime ($CaCO_3$) ..	.. 1-5 ..	.. 1-5 ..	.. Traces .. ..
Total soluble salts	.. Less than 0.2	.. 0.2 to 0.3	.. Nil.
Base exchange capacity (M.E.)/100 g.	30-60 ..	.. 70-80 ..	.. 15-20 .. ..
Base saturation ..	.. 100 ..	.. 100 ..	.. 70-80 .. ..
Percentage Sodium saturation.	Less than 10	.. Less than 10	.. Less than 5 ..
PH	.. 7.5-8.5 ..	.. 8.0-8.5	.. 5.0-6.0 .. ..

No. I-2

IMPORTANT SOILS OF MAHARASHTRA STATE.

Coastal alluvial	Coastal saline	Saline Soils	Alkaline Soil
(5)	(6)	(7)	(8)
All along the coast.	Along the coast and creeks.	Scattered all over the State.	Scattered in all the soil zones and specially in deep black soil regions.
Alluvium from Trap.	Alluvium from Trap.	Trap	..
Semi-humid	Semi-humid	Arid	Arid.
2032-2540	2032-2540	635-762	635-762.
Tall grass	Sal-bush	Salt-tolerant plants	Alkali resistant plants
Variable	Flat	Flat or basin shaped	Flat to slightly sloping
More than 1.5	More than 1.5	More than 1.5	More than 1.5.
Clay loam to loam.	Clay loam	Clay loam to clay	Clay loam to clay.
Brown to Greyish black.	Greyish black	Greyish black	Black or brownish black.
50-60	40-70	40-50	50-60.
15-20	10-12	12-15	10-12.
80-100	100-125	100-125	100-125.
100-200	150-200	150-200	150-200.
10-15	10-15	15-20	20-25.
5-10	5-10	15-20	15-20.
1-5	1-5	2-6	1-6.
0.1 to 0.2	More than 3	More than 1	0.4 to 1.0.
25-30	30-40	60-70	50-70.
100	100	100	100.
Less than 10	10-15	Less than 15	More than 15.
7.0-7.5	7.5-8.0	8.0-8.5	8.5-9.0.

20. Climatic and Agro-climatic Zones of Maharashtra

The crop pattern of a region depends upon soils and climate which means fertility of soil and effectiveness of rainfall dependent on temperature range. The agro-climatic zones of Maharashtra and crop pattern are given below.

On the basis of climate Dr. Basu (1965-70), and others recognise five climatic regions of India.

(1) *North-West India.*—Comprising West Rajasthan, Punjab and Kashmir.

(2) *Central India.*—This includes East Rajasthan, Gujarat, the northern divisions of Madhya Pradesh, Uttar Pradesh and Bihar.

(3) *North-East India.*—Comprising West Bengal, Orissa and Assam.

(4) *The Plateau region.*—Comprising the southern divisions of Madhya Pradesh, the Deccan Plateau, Vidarbha and Chhota Nagpur.

(5) *The Peninsular.*—Consisting of coastal lands and plains.

The Desh part of Maharashtra including Vidarbha and Marathwada belongs to the 4th region above and Konkan belongs to 5th region. The nature and distribution of forests is largely governed by the ecological factors operating there, and on the nature of terrain. The agro-climatic zones on the other hand are largely dependent on the climate and soil, their nearness or distance farther from Sahyadris and Arabian sea. Since the soil is second important factor in crop production, these zones do not necessarily coincide with geological divisions of Maharashtra nor with their natural vegetational divisions. On the basis of soil and climate agronomists have divided Maharashtra into nine parts demarcating into broad agro-climatic zones (see Zende 1969). They are as follows:—

21. Broad Agro-Climatic Zones of Maharashtra

Zone 1.—Very high rainfall and lateritic soils (Chandgad, Radhanagari, Bavda, Shahuvadi talukas of Kolhapur district and the southern part of Mahad, Poladpur in Raigad district).

Rainfall 2500 mm and more max. temperature 30°—31°C, minimum 22°—24°C.

Topography-hilly.

Zone 2.—Very heavy rainfall soils not lateritic—part of Raigad district, entire Thane district, Igatpuri, Peth, Trambak and Surgana in Nasik district.

Topography—Low hills 300 m high.

Zone 3.—The ghat zone—Uneven narrow strips North to South along Sahyadris. Altitude on sea side 1000 m and about 600 m towards Desh side which is sloping. Rainfall 5000 mm. Terrain highly undulating, maximum and minimum temperatures are the lowest of all zones.

Amba, Amboli, Fonda ghat, Koyna, Mahabaleshwar, Khandala, Lonavala, Kalasubai and Harishchandragad, Akola, Bhandardara in Ahmadnagar district, Igatpuri and Trambak in Nasik district, Melghats in Amravati district.

Zone 4.—Transition Zone 1.—A narrow north-south strip lying immediately on the eastern side of the Sahyadri ranges and running parallel to them. Western hilly part of Kolhapur, Shirala, Padgaon, Patan, Medha, Velhe, Paud, Vadgaon, Khed, Ambegaon, Akola (Dist. Ahmednagar), Vani, Dindori, Trambak, Surgana, Junnar.

Rainfall is 1750-2000 mm. Crops grown—Paddy, *nagli* and niger seeds.

Zone 5.—Transition Zone 2.—This zone runs parallel to Transition zone 1, but is much wider. It covers Pune, Kolhapur, Nasik and Ahmadnagar districts, Akkalkot taluka in Solapur district, Akrani, Taloda, Nandurbar and Sakri talukas in Dhule district. Summers and winters are warmer than in Zones 3 and 4. Soils are trap soils. It is essentially a kharif crop zone of bajri, jowar, groundnut, cotton and paddy when irrigated.

Zone 6.—Scarcity zone.—This is the draught prone zone of Maharashtra. It includes a part of Ahmadnagar, a part of Pune, Solapur, Beed, Osmanabad, Districts, Parenda, Bhoom and Akkalkot talukas. Rainfall about 700 mm. but often less than 500 mm. Soils are calcarious, but in valleys dark, deep and grey. Kharif crops of safflower, bajri, and rabi crops like wheat, gram, jowar are grown, but there is always an uncertainty of rains.

Zone 7.—Assured Rainfall area.—It includes major part of Akola, Amravati, Aurangabad, Osmanabad, Beed districts, and half of Parbhani district. It is bound by 700 mm isohyet on the west and 500 isohyet on eastern side. The soils are black or greyish trap soils but contain more of clay. Water gets logged in them. Topography of soil is all flat. This zone is excellent for kharif crops like jowar. Yields here are the highest in State.

Zone 8.—Zone of moderate rainfall.—This includes the whole of Yeotmal, Wardha and Nagpur districts a part of Akola, Amravati, Parbhani and Nanded and western part of Chandrapur district. It receives 900 mm. of rain on western side and 1250 mm. on eastern side. Soils are grey or deep black, trap soils. All kharif and rabi crops grow here, especially on heavy soils.

Zone 9.—Zone of high rainfall.—Soils derived from mixed parent rock (HRM), granites, gneisses, yellowish, brown to red in colour ; coarse in texture.

This zone includes the whole of Bhandara district and mountainous parts of Nagpur and Chandrapur districts in extreme eastern region of the State. Rainfall higher than in Zones 7 and 8 ; about 1250 mm. Soil pH 7.2 in Bhandara district ; 7.5 in Chandrapur district, Natural vegetation deciduous open forests of teak.

Crops.—Rice in kharif season and wheat, gram, linseed, some jowar in Rabi season.

TABLE No. I-3

Analysis of Various Soils and Their Properties in Districts of Maharashtra

Ratnagiri District

PH (1)	Total soluble salts (2)	Silts (3)	Clay (4)	Ex. Ca (m.e.) 100g. (5)	Ex. Mg. (m.e.) 100g. (6)	Ex. Na+K (m.e.) 100g. (7)	Total Nitrogen (8)	Av. P_2O_5 (mgm.) 100g. (9)	Av. K_2O (mgm.) 100g. (10)
6.7 Percent	0.09 Percent	18.8 Percent	23.25 Percent	8.0 Percent	5.5 Percent	2.0 Percent	0.13 Percent	10.29 Percent	14.67 Percent

Raigad District (1) Deep Soils

Depth (1)	PH (2)	T.S.S. (3)	Silt (4)	Clay (5)	Ex. Ca (m.e.)100g. (6)	Ex. Mg. (m.e.)100g. (7)	Ex. Na+K (m.e.) 100g. (8)	Ca Co_3 (9)	Total Nitrogen (10)	Av. P_2O_5 (m.e.) 100g. (11)	Av. K_2O (m.e.) 100g. (12)
0-20	6.7	0.15	..	28	24	12	2.5	32	ND	14	18
20-40	7.3	0.18	..	17	24	10	1.5	27	..	..	..
40-70	0.20	0.20	..	10	18	15	1.0	20	..	..	..

Non-Lateritic and Coastal Soils at Roha

PH (1)	Coastal alluvium (2)	T.S.S. (3)	Silt (4)	Clay (5)	Ex. Ca (m.e.)100g. (6)	Ex. Mg. (m.e.)100g. (7)	Ex. Na+K (m.e.) 100g. (8)	Coastal alluvium (9)	Total Nitrogen (10)	Av. P_2O_5 (m.e.) 100g. (11)	Av. K_2O (m.e.) 100g. (12)
7.5	15-27	0.26	24	27	24	13	1.0	6-10	0.08 Percent	13.64	20

PUNE DISTRICT

Depth	PH	T.S.S.	Silt Percent	Clay Percent	Ca Co_3	Ex. Ca	Ex. Mg. (m.e.) 100g.	Ex. Na+K	Total Nitrogen	Av. P_2O_5 (mgm.)100g.	Av. K_2O (mgm.) 100g.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
0-15	7.5	0.18	29	26	0.28	31	4	5	0.080 Percent	..	..
15-45	7.4	1.33	22	31	0.28	42	2	3	..	..	..
45-90	7.4	1.00	12	38	0.51	46	1	3	..	..	..

NASIK DISTRICT

PH	T.S.S.	Silt	Clay	$CaCo_3$	Ex. Ca (m.e.)100g.	Ex. Mg. (m.e.)100g.	Ex. Na+K (m.e.)100g.	Total Nitrogen	Available K_2O Potash (mgm.) 100g.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
8.3	0.31 Percent	18.50 Percent	28.50 Percent	5.0 Percent	35.0 Percent	9.5 Percent	2.0 Percent	0.05 Percent	25.90 Percent

AHMADNAGAR DISTRICT

PH	T.S.S.	Silt	Clay	$CaCO_3$	Ex. Ca. (m.e.)100g.	Ex. Mg. (m.e.)100g.	Ex. Na+K (m.e.)100g.	Total Nitrogen	Av. K_2O. (mgm.)100g.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
8.05	0.29 Percent	14.25 Percent	47.00 Percent	9.09 Percent	46.05 Percent	5.50 Percent	1.05 Percent	0.06 Percent	30.40 Percent

TABLE No. I-3—*contd.*

SATARA DISTRICT

Depth	PH	T.S.S.	Silt	Clay	CaCO3	Ex. Ca	Ex. Mg.	Ex. Na+K (m.e.) 100g.	Total Nitrogen	Available P_2O_5 K_2O
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
0-30	8.9	0.30	12	48	4.5	43	10	1.5	0.042	8.0 16
30-60	8.0	0.36	9	54	4.6	37	7	3.0	Percent	Percent
60-90	8.9	0.74	11	54	4.6	34	2	3.5	Percent	Percent

SANGLI DISTRICT

Phase and Depth	PH	T.T.S. Percent	Silt Percent	Clay Percent	CaCO3	Ex. Ca (m.e.) 100g.	Ex. Mg. (m.e.) 100g.	Ex. Na+K (m.e.) 100g.	Total Nitrogen	Available P_2O_5 K_2O (mgm.) 100g.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Shallow 0-15	7.6	0.20	16	45	2.0	37	10	..	0.03 Percent	12 16
Very deep 0-29	8.8	0.30	18	47	8.2	33	7	3.5	0.07 Percent	22 20
29-59	8.8	0.49	16	50	8.9	25	5	5.5		
59-90	8.3	0.57	12	53	9.9	21	8	5.5		
90-115	8.8	0.74	15	50	9.7	16	10	6.0		

SOLAPUR DISTRICT

PH	Total soluble salts	Silt	Clay	$CaCO_3$	Ex. Ca (m.e.) 100g.	Ex. Mg. (m.e.) 100g.	Ex. Na+K (m.e.) 100g.	Total Nitrogen	Av. K_2O (mgm.) 100g.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
8.3	0.38 Percent	17.75 Percent	45.50 Percent	6.9 Percent	47.5	10.5	2.5	0.05 Percent	14.00

PARBHANI DISTRICT

PH	Total soluble Salts	Silt	Clay	$CaCO_3$	Ex. Ca (m.e.) 100g.	Ex. Mg. (m.e.) 100g.	Ex. Na+K (m.e.) 100g.	Total Nitrogen	Av. P_2O_5 (mgm.) 100g.	Av. K_2O (mgm.) 100g.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
8.2	0.22 Percent	21.50 Percent	27.50 Percent	5.50	41.50	10.00	2.0	0.04 Percent	8.15	12.90

WARDHA DISTRICT

PH	Total soluble salts	Silt	Clay	$CaCO_3$	Ex. Ca (m.e.) 100g.	Ex. Mg. (m.e.) 100g.	Ex. Na+K (m.e.) 100g.	Total Nitrogen	Av. P_2O_5 (mgm.)100g.	Av. K_2O (mgm.)100g.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
8.4	0.25 Percent	21.50 Percent	41.00 Percent	5.9 Percent	45.6	10.3	1.5	0.05 Percent	13.69	25.07

TABLE No. I-3—*contd.*

NAGPUR DISTRICT : PLACE SHIVANGAON

PH	T.S.S.	$CaCO_3$	Clay	Ex. Ca (m.e. 100g.)	Ex. Mg. (m.e. 100g.)	Ex. Na+K (m.e. 100g.)	Total Nitrogen	Av. P_2O_5 (mgm. 100g.)	Av. K_2O (mgm. 100g.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
8.0	0.27	3.0	44.75	40.0	8.9	1.5	0.05 Percent	13.47	24.16

CHANDRAPUR DISTRICT

PH	T.S.S.	Silt	Clay	$CaCO_3$	Ex. Ca (m.e. 100g.)	Ex. Mg. (m.e. 100g.)	Ex. Na+K (m.e. 100g.)	Total Nitrogen
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
7.5	0.32 Percent	17.50 Percent	31.50 Percent	1.9 Percent	22.00	6.5	1.0	0.04 Percent

22. FORESTS OF MAHARASHTRA—

A forest is a plant community naturally formed or planted or both, grown mixed. The total area of Maharashtra is 3,07,183 hundred hectares of which 54,188 hundred hectares are under forests. The proportion of area under forests to the total area is 21.8 per cent. Compared to the forest area in the adjoining States it is less than that of Madhya Pradesh (39 per cent) and Orissa (43.7 per cent). In comparison to Karnatak where it is 18.41 per cent and Gujarat which has 10.4 per cent, it is more. In Maharashtra 11,192 hundred hectares are fallow lands and 13,799 hectares are grazing lands. Area under agriculture is 68·8 per cent or 30·58 crore hectares. However, not all the area under the forests is gainfully productive. On account of the peculiar geographical situation and terrain the forests in Maharashtra are mainly concentrated in the following regions :—

(1) Chandrapur-Bhandara region at the extreme east end of the State.

(2) In the valleys of Tapi in Khandesh having a different climatic set up and in Satpuda ranges.

(3) The western and eastern flanks of Sahyadris, mainly in the Western ghats. Besides these, there are a few other forests representing the edaphic climax such as mangroves, beach forests, forests on riverine terraces, etc.

(4) In Melghats the spurs of Satpudas starting from the main ranges extend eastwards on the Desh side which are mostly dry. Here only dry deciduous or scrub vegetation occurs. Some forests with stunted growth occur on the top of the ghats.

The best forests in Maharashtra are in the Chandrapur-Bhandara region and at a few places in the valleys of Sahyadris on the east and west sides, in Melghat and in low hills of Ajantha-Satmala ranges.

A natural forest is a plant community. It generally represents the climatic climax vegetation of the place. A forest represents sometimes a natural climatic climax vegetation and sometimes it does not. It may be a seral stage. The climatic climax vegetation in a particular area in its natural state primarily depends upon the climate which means rainfall, temperature range and percentage humidity during different months of the year. The natural climatic zones of the world and of forests are primarily determined on the basis of the latitude, sunshine and altitude, rainfall, humidity and temperature ; secondarily on soil factors, topography. Tertiarily they are controlled or determined by the biotic factors, collectively called biota, which means effect or impact of plants on plants and of animals on plants and *vice versa*, and of man. They are, therefore, classified as tropical, sub-tropical, temperate, sub-temperate, Alpine and Arctic and sub-arctic. Besides these, there are deserts hot or cold tundras, prairies (grasslands), steppes, etc. This classification based on latitude does not seem to be very appropriate for the Indian conditions as we have no Alpine vegetation except in Kashmir or cold tundras or grassy steppes in India. Our high altitude forests are really the Montaine forests akin to those in Malaysia, Burma etc. As a result, the different authors have proposed different classification of the forest types such as Schimper and Chipps (1923), Davy (1936), Champion (1936), Champion and Seth (1968), Puri (1960) etc. Table I-4 below gives important views on the classification of forest types briefly

TABLE No. I-4—Classification of Forest Types

After Puri. (1960), (Table 25 pp. 99-101)

Sr. No. (1)	Burtt Davy's classification for the tropical vegetation (2)	Champion's classification for India (3)	Schimper and Chipp's and other classifications of tropical vegetation (4)	Brief description of the type (5)
(A)	*Wood land formation in the tropics.* (a) Moist Wood lands in the tropics. (i) Moist climatic formations.			
1	Tropical low land evergreen rain forest.	Wet evergreen forest (Rain Forest).	Rain forest; Tropical rain forest, Lowland rain forest, Equatorial rain forest; wet evergreen forest	This is a closed, tall evergreen forest with at least lofty, tall trees, many reach 200 ft., buttressed with woody lianas; Woody epiphytes, large leaves.
	Sub-formations:			
	Tropical lower montane evergreen rain forest.	Montane subtropical forest.	Subtropical rain forest; Montane; sub-tropical forest.	It does not appear to differ sufficiently from the last named formation.
2	Tropical Semi-evergreen rain forest.	Tropical semi-evergreen forest.	Tropical semi-evergreen forest; Semi-evergreen forest; Evergreen forest; Transition forest; Mixed deciduou forest; Wet mixed forest.	Dominants include deciduous species, but evergreen predominate.
3	Tropical moist deciduous forest.	Tropical moist deciduous forest includes the important *Tectona grandis* or bearing forests, *Terminalia* forests of Bombay and the Padauk forests of the Andaman.	Monsoon forest, Tropical moist deciduous forest; Moist deciduous forest, Moist mixed deciduous forest, Mixed deciduous forest in part.	Deciduous are the dominants and evergreens largely form the sub-dominate and lower storeys different. Top canopy rarely dense but over soft high.

4	Tropical upper montane rain forest.	Montane wet temperate forest. Broad leaved evergreen forest without conifers.	Temperate Rain forest in the tropics, Temperate Rain forest; Warm-temperate Rain forest ; Mountain forest, Montane stem Ra n forest; Montane Wet temperate forest ; Warm temperate montane broad leaved Rain forest ; Hill forest ; High forest; cloud forest ; Sub-tropical evergreen forest .	Trees evergreen, broad leaved Lianes fewer and thinner in stem : Epiphyes, harbaceous mostly cryptogams than Phanerogams with luxuriant development of epiphytic lichens or mosses.
5	Tropical high montane conifer forest.	Montane temperate coniferous forest.	Montane temperate Coniferous forest, warm temperate evergreen conifer forest.	The coniferous genera *Widdringtonia* in Nysa'and and *Juniperus* 'n Kenya form an evergreen forest zone at 7,000 to 9,000.
6	Tropical montane bamboo forest.	Temperate bamboo brakes (Not accepted as climax.)	Temperate Bamboo brakes	It occurs between 7,500 and 11,000 ft on the equatorial mountains of East Africa. *Arundinaria alpina* dominant growing to 40 to 65 feet.
	Tropical alpine elfin-wood-land.	Alpine forests of the Himalayas	Alpine forest, Elfin-Wood, Krummhole, Sub-alpine evergreen scrub forest.	It is a *belt of Alpine* wood-lands not found in Maharashtra above the Tropical high montane conifer forest and the tropical montane Bomboo forest.
8	(ii) Moist edaphic formations. Tropical Riparion Wood-land.	Riparian forest.	Fringing forest, Riverine forest, Moist Riparian fringing forest ; Gallerie-Wald (German) ; Gallerie. forest (French), Riparian fringing forest ; Hydrophilous fringing bush.	
9	Tropical fresh water swamp forest.	Tropical fresh water swamp forest.	Swamp vegetation	On water-logged alluvial soil consists of several tires, tall trees 60 to 70' high, small trees, shrubs and plants clothing the ground.

CLASSIFICATION OF FOREST TYPES—*contd.*

(1)	(2)	(3)	(4)	(5)
10	Tropical Palm Swamp ..	Not found in India ..	Tropical palmgrove	Palm-groves devoid of grassy ground cover frequently occur on soils which become swampy. e. g. in N. E. F. A. and Assam.
11	Tropical mangrove wood-land.	Tidal forest	Mangrove, Mangrove Swamp; Tidal forest.	Below high tide mark; sometimes forest like, sometimes shruby or full of bushes.
12	Tropical littoral wood-land	Beach forest, Dune forest ..	Strand vegetation, Beach forest	On sandy and gravelly sea shores, not subject to immersion but under constant maritime influence, often sclerophyllous.
	(b) Dry Wood-land in the tropics.			
13	Tropical dry evergreen forest	Tropical dry evergreen forest	Dry evergreen forest, Dry zone forest ..	Hard-leaved evergreen trees predominate under 60 to 80′ high; Stocking often dense.
14	Tropical savannah wood-land	..	Tree savannah; Bush savannah. Park-land; Dry forest; Tree veld; savannah forest; Tockenwald (German).	Xerophilous trees, deciduous, small-leaved; top canopy light scattered shrubs, much tufted grass. Rainfall mostly below 50 inches cold season rainfall less.
	Sub-formation :			
(i)	Thorn forest	Thorn forest	..	Dense thorny bushes, thin stemmed climbers; general absence of grasses.
(ii)	Savannah - thorn land. .	Not found in India	..	Thorny shrubs and trees predominate. Ground cover of grass and other herbs.
(iii)	Thorn scrub ..	Not found in India		Grass absent, succulents abundant, Thorny trees few; passs into desert.

(B)	*Grass land formations in the tropics.*	..	Grass land, Savannah, Grassy Steppe, Meddows ; Marsh grass land ; Mountain.	Herbaceous vegetation, Tress or shrubs, scattered, Grasses or sedges predominate, Hygrophibus or xcrophitous.
15	Tropical grassland	Not found in India	..	Rainfall 10-20 inches or more, fairly evenly distributed.
(C)	*Desert formations in the tropics.*			
16	Desert vegetation	Not given by Champion, but found in India.	..	Sparse community, stunted trees and shrubs, annual or perennial herbs ; plants xeromorphic and succulent, Morphological type dependent on direct precipitation or on direct precipitation or on telluric moisture.
	Sub-formation :	Not given by Champion but found in India.	..	Vegetation xerophytic, less sparse than that in a true desert.

However, for all practical purposes Champion and Seth's classification (1968) is followed in forestry practice in India. However, it is necessary to state that in many places our present day forests represent not the climatic climax vegetation, but a degradation series due to human interference, soil erosion, and geophysical changes etc. They have greatly affected them and hence, they do not always represent the climatic climax. For example, when large trees in coupes in a forest are auctioned and timber trees are cut down, bamboo brakes develop and when bamboos are cut then the area is quickly covered by *Lantana camara*. These are degrading changes. They are quite obvious in areas where Kumali cultivation is practised or in forests below high hill forts and such places where only *Lantana camara* bushes are seen, due to man's interference.

The greater part of Maharashtra to the East of Sahyadris is Desh. It is dry for major part of the year and humid only in the rainy season for about 100 to 120 rainy days, rest of the days in an year are dry. The country largely depends upon the monsoons for precipitation and growth of plant, and hence the usual prayer of people of India is "Let there be timely rains and turn earth into green !" "काले वर्षंतु पर्जन्य :, पृथ्वी सस्य मालिनी !"

The climate during the rainy season is monsoonic and for the rest of the year dry or semi arid, hot or cold. Because of these climatic peculiarities, no particular system of the classification of forests can be adopted in toto. It has to be accepted with some modification and certain limitation. Champion and Seth (1968) whose system is generally followed have classified the Indian forests into 18 climatic forest types as follows :—

I. Tropical West Evergreen Forests :—

Annual mean Temperature ..	27.2°C	At Mangalore.
Annual Rainfall ..	3292mm.	
Annual Humidity ..	77 percent	

Here the trees form forest canopy, multilayered, evergreen trees more than 45 m. high with numerous epiphytes, but climbers only a few. This is found on the Western face of the Western ghats in small pockets in valleys. The constituent trees are *Mesua ferea, Dysoxylum, malabaricum, Calophyllum inophyllum, Artocarpus sp., Hopea wightiana Syzyqium cumini.*

II. Tropical Semi-Evergreen Forests :—

Annual mean Temperature ..	26.3°C	At Karwar.
Annual Rainfall ..	3606 mm.	
Annual Humidity ..	80 percent	

Forest high with large tall trees, close. Deciduous trees often have buttressed trunks with thick woody climbers, epiphytees abundant, bamboos infrequent. This type does not occur in Maharashtra. The trees here are *Artocarpus ~~hirsuta,~~ Lagerstroemia lanceolata, Anthocephalus kadamba, Dalbergia latifolia, Terminalia tomentosa, Adina cordifolia, Pterocarpus marsupium, Holopetelea integrifolia.*

III. Tropical Moist Deciduous Forests :—

Annual mean Temperature	.. 27·10°C	At Chandrapur.
Annual Rainfall	.. 1324 mm.	
Annual Humidity	.. 56 per cent	

This type occurs throughout the moist part of Maharashtra, Gujarat, Madhy Pradesh, Mysore etc. Top storey of vegetation predominantly of deciduous species, irregular, trees 40 m. or more high heavily buttressed. Second storey of predominantly deciduous plants mixed with some evergreens. Undergrowth shrubby, climbers dense ; canes and many Bamboos grow in places as undergrowth. This is the main type that is seen in Allapalli forests of Chandrapur.

Trees occurring here are *Tectona grandis, Semecarpus anacardium, Salmalia malabarica* (Silk cotton tree or Semul), *Lagerstroemia parviflora, Xylia xylocarpa, Grewia tiliaefolia, Terminalia paniculata, Schleichera trijuga, Embelica officinalis* and *Dendrocalamus strictus.*

IV. Littoral and Swamp Forests :—

Annual mean Temperature	.. 27.9°C	At Kakinada in Andhra Pradesh.
Annual Rainfall	.. 1042 mm.	
Annual Humidity	.. 73 per cent	

These consist of evergreen species with variable density and height of trees. They occur near sea coast, estuaries and river deltas. Temperature here being constant and rainfall abundant, there is great humidity throughout the year. Mangroves of Raigad, Thane, Greater Bombay, Ratnagiri, Chiplun, Terekhol in Sindhudurg district belong to this.

Littoral forests :—They represent edaphic climax. They have some small evergreen and some deciduous trees. Surface creepers like *Ipomoea biloba* and maritime grass *Spinifex sguarasa* abundant in areas where fresh water is available. Tall grass Phragmites occurs at some places on Malvan, Vengurla coast.

Mangrove scrub and strand plants :—This forms dense growth on muddy coastal flats and river deltas. *Sonneratia apatala, Agiceras majus, Avicenia officinalis Acanthus, ilicifolius* grows mixed with creepers of *Tylophora indica.* Behind these there are tropical riverine forests fringing the river banks at Janjira, (Murud), etc. By *Lagerstroemia parviflora, Terminalia arjuna, Salix tetrasperma, Premna asiatica.*

V. Souhern Tropical Dry Deciduous Forests :—

Annual mean Temperature	.. 27.3°C	At Nagpur.
Annual Rainfall	.. 825 mm.	
Annual Humidity	.. ..	

These consist of a number of mostly deciduous species. They dry up in summer months. Their upper canopy is not close. Trees are generally 20 m high. Different species predominate in different areas, but they are not gregarious, heterogenous. The canopy having been made up of deciduous small trees, or tall shrubs permitting light to reach the forest floor where good grass grows. Climbers are few. Some like *Entada pusaetha* are large and woody. Bamboos are present. A few epiphytic ferns and orchids occur. This type is abundant throughout the Western region of Maharashtra and other parts of the Western ghats.

Tall Teak Forests.—Here dry deciduous species such as *Terminalia tomentosa*. *Adina cordifolia*, *Schleichera trijuga* occur with *Tectona grandis* which is the main species. It occurs also in Madhya Pradesh in Bastar area and in parts of other States adjoining Maharashtra.

Southern moist mixed Deciduous Forests.—They are common in ghat section and in Chandrapur area. *Terminalia bellerica*, *Pterocarpus marsuipium*, *Salmalia malabarica* *Anogeissus latifolia*, *Dalbergia sisoo*, *D. latifolia* occur in plenty.

Southern Dry Mixed Deciduous Forests.—They are formed by *Boswelia serrata*, *Bamboos*, *Bauhinia vahlii*, *Acacia torta* and *A leucophloea*. Rainfall is 975-1500 mm. They occur on well drained hill sides and are very common in Bhandara district. The trees are : *Terminalia tomentosa*, *Lagerstroemia parviflora*, *Soymida febrifusa*, *Anogeissus latifolia*, *Acacia catechu*, *Emblica officinalis*, *Zizyphus xylopynes*, *Chlroxylon sweitenia*, *Ougeinia oojeinesis*, *Lannea grandis*, *Woodfordia fruiticosa*, *Helicteris isora*, *Nyctanthes orbor tristis*, *Dendrocalamus strictus*. The forests near Chaturshringi at Pune and Katraj belong to this type. *Santalum album*, *Gymnosporia montana*, *Gymnosporia spinosa*, *Osyris wightiana*, *Rhus mysorensis*, *Acacia leucophloea*, a few plants of *Cochlospermum gossypium* and *Stereospermum personatum*, *Dolichandrone falcata* occur here, besides various grasses. The area has some deciduous trees as in dry deciduous forests and some species go to form a thorny scrub. Because of these the forests at Chaturshringi are considered to be regressive sere of a mixed deciduous forest.

Dry Deciduous Scrubs.—These grow generally on poor shallow soil with shrubby growth below 3000′ height. Some Bamboos are always present in it. *Randia dumetorum*, *Carissa carandas* bushes of *Dodonia viscosa* and *Zizyphus rugosa* are commonly found.

Dry Grassland.—Here *Schima nurvosum*, *Heteropogon contortus*, *Dichanthium annulatus*. *Themeda triandra* are abundant on hills near Kalyan. These grasslands often get deteriorated. The leafy fodder grasses get replaced by annual woody ones, especially by *Heteropogon contortus*, *Aristida histrix*, *Eragrostis aspera* and *Symbopogon martini*.

Various edaphic climax types of dry deciduous forests are known, e.g. *Babhul* forests between Daund and Pune. *Hardwickia binata* forests between Malegaon and Dhule, bamboo brakes in Melghat are some examples. They indicate secondary succession.

Babhul or Babul Forests.—*Acacia arabica* grows markedly gregariously. Undergrowth is very little and grass cover is thin for grazing. The original type is much altered due to grazing. A similar type with *Balanites roxburchii*, *Acacia leucophloea*, *Prosopis spicigera*, *Azadirachta indica*, *Casearia grandis*, *Butea monosperma* form a similar degraded forest series from dry deciduous forest in Vidarbha, Marathwada Hills, Kinwat etc. These are much altered forest areas due to man's interference.

VI. Tropical Thorn Forests :—

Annual mean Temperature		27.0°C
Annual mean Rainfall	..	691 mm.
Annual mean Humidity	..	47 %

This is a low open xerophytic forest containing thorny leguminous plants. Trees have low branches and short boles. Lower storey consists of xerophytic bushes and spiny shrubs such as *Acacia torta*, *Azadirachta Indica* (Neem), *Phoenix sylvestris*, *Butea monosperma* (Palas) which predominate.

VII. Tropical Dry Forests :—

Average mean Temperature	27.9 ° C
Average mean Rainfall ..	1052 mm.
Average mean Humidity ..	74 per cent

This is a low forest type having trees 12 m high. They have short boles and rather small, coriaceous leaves. There is no differentiation of layers. Bamboos are very rare. Growth is not sparse. This type is restricted to a small coastal area adjoining Sawantwadi, Goa and Karnatak.

VIII. Western Sub-tropical Broad-leaved Hill Forests :—

Annual mean Temperature	21.4 ° C ..	Panchmadhi
Annual mean Rainfall ..	2022 mm. ..	
Annual mean Humidity ..	57 % ..	

The species here are *Actinodaphne hookeri*, *Memecylon umbellatum*, *Randia dumetorum*, *Flacourtia latifolia*, *Terminalia chebula*, *Olea dioica*, *Glochidion hohenackeri*, *Pouteria tomentosa*, grasses like *Dicanthium*, *dicocium*, bushes of *carvia callosa*, *Scutia myrtina*, *Pogostemon plact-ranthoides*, *Lasiosiphon eriocephallus*, *Elaeagnus latifolia*, *Allophyllus cobbe*, *Capparis pedunculosa*, *Zizyphus rugosa*, *Pavetta indica* etc.

IX. Sub-tropical Pine Forests :—

This type is found through out NW Himalayas at an altitude of 1000-1800 m. It is common in Khasi, Manipur and Naga Hills. It does not occur in Maharashtra.

X. Sub-tropical Dry Evergreen Forests :—

This is practically a low scrub formed by small evergreen trees and shrubs and thorny bushes. Herbs and grasses appear in monsoons only. This type is common in Siwalik hills in NW Himalayas.

XI. Montane Wet Temperate Forests :—

This type, with trees 6 m or less high have large bole, spreading branches dense crown. Leaves are generally coriaceous. Branches are abundant clothed with mosses, ferns and other epiphytes. Climbers are woody. They are common in the hills of Madras and Kerala about 150 m high and in higher hills of Bengal, Assam, NEFA in Eastern Himalayas from 1800-3000 m. but absent in Maharashtra.

XII. Himalayan Moist Temperate Forests :—

These are purely of conifers 30-50 m high, mostly with evergreen species.

Mosses and ferns grow abundantly on tree trunks. It is found throughout Himalayas in Alpine and Sub-Alpine regions of Kashmir, Himachal Pradesh, Punjab, U. P., Darjeeling, Sikkim between 1500-3300 m at Chakarata (U. P.), in Sutlej valley in Himachal Pradesh. This is absent in Maharashtra.

XIII. Himalayan Dry Temporary Forests :—

These are coniferous forests, but have a mixture of xerophytic shrubs in them. Some epiphytes and climbers occur in them. SW Monsoon here is weak, less than 100 mm. It occurs abundantly in Ladakh, Gadhwal and Sikkim, but absent in Maharashtra.

XIV. Alpine Forests :—

The Alpine forest types occur at 3000-4000 m in Himalayas. In sub-Alpine type small conifers and large shrubs occur nearly at the upper limit of the tree line in Himalayas, adjacent to Alpine scrub and grassland in the Kulu valley. Main species belong to *Larirx*, *Rhododendron* and *Taxus baccata*, *Picea excelsa*. It is not present in Maharashtra.

XV. Moist Alpine Forests :—

This type occurs throughout Himalayas above 3000 m. They have dense growth of low evergreen *Rhododendrons*, bushes of *Berberis*, *Betula* (Birch) etc. Mosses, ferns, honeysuckle (*Lonifera*), a few flowering herbs grow commonly as undergrowth. This is not present in Maharashtra.

XVI. Dry Alpine Scrub :

This occurs at the uppermost limit of xerophytic scrub formed by dwarf shrubs above 3500-4000 m in the Himalayas. Species of *Juniperus*, *Artemesias*, *Potentilla*, and *Lonifera* occur here. This is not found in Maharashtra.

XVII. West Coast Semi-evergreen Forests :—

These occur between wet evergreen and moist deciduous forests in small narrow strips. They are much altered due to biotic factors operating in Western Ghats. Species found here are *Terminalia paniculata*, *Diospyros assimilis*, *Alycicarpus seratus*, *Lagerstroemia lanceolata*, *Holigarna arnottiana*, *Cinnamomum tamala*, *Hopea parviflora*, *Mallotus philippensis* and large climbers of *Anodendron paniculatum* and *Entada pusaetha*, *Calamus pseudotenuis*, *Vitex negundo*, *Kydia calycina*, *Terminalia belerica*, *Elaeodendron seratus*, *Glycosmis pentaphylla*, *Bambusa arundinacea*.

XVIII. Lateritic Semi-evergreen Forests :—

These consist of *Xylia xylocarpa*, *Anogeissus latifolia*, *Grewia tiliaei folia*, *Terminalia* sp., *Careya arborea*, *Bridelia retusa*, *Calycapteris floribunda*, *Strychnos nux-vomica*, *Leea macrophylla*, *Adhatoda vasica*, *Holarrhena antidysentrica* and occasionally *Grewia nudiflora*.

It will be seen from the above that from among the 18 forest types characterised by Champion and Seth (1968), not all occur in Maharashtra. The types listed below occur in Maharashtra :—

1. Tropical Wet Evergreen Forests
2. Tropical Semi-Evergreen Forests
3. Tropical Moist Deciduous Forests
4. Tropical Dry Deciduous Forests
5. Tropical Thorn Savannah.
6. Tropical Edaphic Forests.

These mainly consist of lateritic ghat forests of dry trees such as *Hardwickia, binata Memeceylon edula, Butea monosperma. Acacia arabica, Capparis horrida* and such other species

7. Littoral Zone Forests (Mangroves and Beach forests). These are Tidal zone forests in fresh water and marshy swamps.

8. Broad or small-leaved forests of Montane types: All these forests are not economically important though ecologically they are important in maintaining the vegetational balance. Champion and Seth (1968) recognise various sub-types in each. Bamboo and cane brakes are generally considered to be of secondary origin due to breakdown of a Dry Deciduous forest ; and as such, they present several stages in the breakdown of Dry Deciduous Forests.

Consideration of their vegetation, ecology, products and productivity is important.

All these forest types are distributed in different Forest Divisions of the State described later. The predominant type on Desh side is Dry Deciduous Forest, which is ecologically and economically the most important. It has been present in the Deccan Trap country since Eocene period. Its origin is considered to be from evergreen forests by Mahabale (1979), Meher Homji. The evolution of them is generally believed to be as follows :—

Evergreen forests, Semi-evergreen forests, Moist deciduous forests, Dry deciduous forests, Scrub or open temporary grass lands of animal forage grasses.

All these forests are useful for the vegetal cover of Maharashtra, but only some of them are economically important. In these the Dry deciduous Teak forests are the most important and so are the open grass lands. If the conditions of temperature and rainfall are more favourable Dry Deciduous Forests could revert to semi-evergreen type. Flora of these forests has been briefly described by Querishi (1962). Recent finding of Meher Homji (1980) on forests of West coast in Maharashtra, Karnatak and Kerala is that deforestation on large scale shows a trend of decreasing rainfall.

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सत्यमेव जयते

CHAPTER II

GENERAL SURVEY OF DIFFERENT PLANT GROUPS IN MAHARASHTRA—THALLOPHYTA

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CHAPTER II : GENERAL SURVEY OF DIFFERENT PLANT GROUPS IN MAHARASHTRA—THALLOPHYTA

The total number of plants in the world is very large, consisting of over two lakhs of flowering plants and nearly two lakhs of plants without flowers. To know such an enormous number of plants it is necessary to devise some sort of classification of them. Various authors since the days of Aristotle (584-323 B.C.) to the days of Linnaeus (1707-1778), and to the present times have devised various systems of classification. The one which is largely accepted is the system of Eichler (1875-1878) which is as follows :—

A. *Cryptogamas*—

Division I—Thallophyta

Class 1—Algae

Class 2—Fungi

Division II—Bryophyta

Division III—Pteridophyta

B. *Phanerogamas*—

Division I—Gymnosparmae

Division II—Angiospermae

Class 1—Monocotyleae

Class 2—Dicotyleae

To the classes of Thallophyta, above one more Class was added later namely Lichens.

The classification of these plants given by Smith (1938) and others is as follows—

THALLOPHYTA
BRYOPHYTA
PTERIDOPHYTA
GYMNOSPERMAE
ANGIOSPERMAE

CRYPTOGAMIA

THALLOPHYTA

A. ALGAE

EUGLENOPHYTA
PYROPHYTA
CRYSOPHYTA
CHLOROPHYTA
PHEOPHYTA
RHODOPHYTA
CY NOPHYTA

Thallophyta are distinguished by their simple undifferentiated plant body, one-called gametes, or multicellular spore-containing bodies. Sex organs of Thallophyta are extremely simple. Their gametes are not surrounded by a sterile layer or jacket of cells constituting the antharidial and archegonial cover, unlike that in the Pteridophyta or Bryophyta. Sporangia of the Thallophyta are always one-celled as against multicelled sporangia of higher plants. The zygote does not develop into multicellular embryo while within the female reproductive organ. It is customary to recognise three large Classes of Thallophyta: the Algae, the Fungi, and Lichens. The terminology used to denote the various groups among them is varied. The terms used are Chlorophyta, Cyanophyta, Phaeophyta, Rhodophyta etc., or the Chlorophyceae, Cyanophyceae, Phaeophyceae and Rhodophyceae. However, in keeping with the modern trend we shall use terminology for different groups with the suffix 'phyta' to denote each category without entering into theoretical discussion as to whether the term used constitutes a division or a Class. According to this, Algae, Fungi and Lichen would constitute three distinct equivalent sub-divisions of Thallophyta. Algae comprise following five classes :

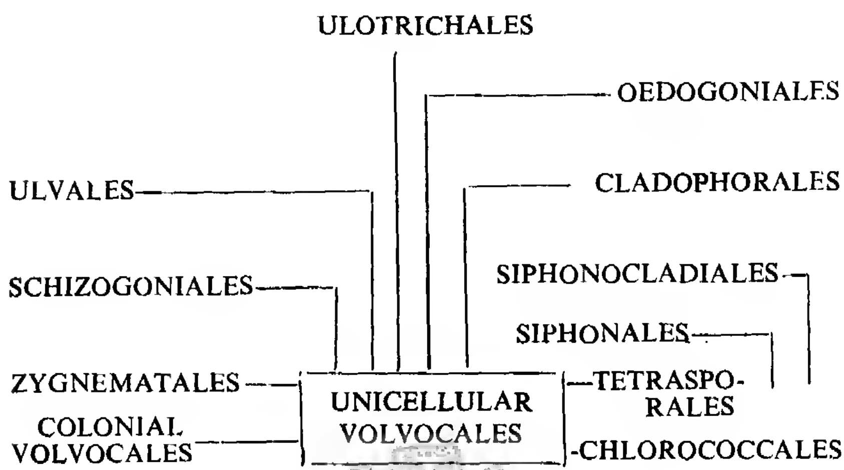
SECTION A—ALGAE

In this Class Chlorophyta plants, are green like grass, possessing chlorophyll, Chlorophyll a and b, Carotene and Xanthophyll. They are the same as in higher vascular plants and are in the same proportion as in them. They are localised in the form of definite plastids, the chloroplasts. They generally form starch as the chief product of photosynthesis. Their body may be unicelled or multicelled, their reproductive cells have generally two; sometimes four, flagella or cilia at their anterior end and as a rule are of equal length. Reproduction may be sexual or asexual. The sexual cells or gametes are produced within the unicellular sex organs. The fusing gametes may be of equal or unequal size. Asexual reproduction may take place by zoospores.

There are 360 genera and 5700 species of Chlorophyta. Majority of them are fresh water plants, others are marine. The fresh water Chlorophyta are rather small ; marine forms are large, easily seen with naked eyes. They make the following families and their relationship is indicated by Smith (1938) as shown in diagram on p. 59.

I	Chlorophyceae (Isokontae)
II	Xanthophyceae (Heterokontae)
III	Chrysophyceae (Chrysoe = golden yellow algae)
IV	Bascillariphoyceae (Diatomaceae).
	Kieselghur or silicious ooze containing many diatoms (Kiesel means silica or sand)
V	Cryptophyceae (Cryptos = minute)
VI	Dinophyceae (Peridineae)
VII	Chloromonadineae
VIII	Eugleninae or unicellular lower flagellate organisms.
IX	Phaeophyceae or Brown Algae (Paias = dusky, Phykos = Sea = weed)
X	Rhodophyceae or Red Algae (Rhodon = Rose)
XI	Myxophyceae or Blue green Algae (Cyanophyceae, Kyanos = blue)

The classification of entire algae given by Smith (1938) is quite elaborate and is given below. The inter-relationship of the Chlorophyta is indicated by the following diagram :



Smith's Classification of algae

I. CHLOROPHYTA

Class 1—Chlorophyceae

Order 1—Volvocales

Family 1—Chlamydomonadaceae

Family 2—Volvocaceae.

Order 2—Tetrasporales

Family— Tetrasporaceae

Order 3— Ulotoichales

Family 1—Ulotrichaceae
2—Microsporaceae
3—Cylindrocapsaceae
4—Chaetophoraceae
5—Protococcaceae
6—Coleochaetaceae
7—Trentepohliaceae

Order 4—Ulvales

Family 1—Ulvaceae
2—Schizomeridaceae

Order 5—Schizogoniales
Family — Schizogoniaceae
Order 6—Cladophorales
Family 1—Cladophoraceae
2—Sphaeropleaceae

Order 7—Oedogoniales
Family — Oedogoniaceae

Order 8—Zygnematales
Family 1—Zygnemataceae
2—Mesotaeniaceae
3—Desmidiaceae

Order 9—Chlorococcales
Family 1—Chlorococcaceae
2—Endosphaeraceae
3—Characiaceae
4—Protosiphonaceae
5—Hydrodictyaceae
6—Oocystaceae
7—Scenedesmaceae

Order 10—Siphonales
Family 1—Bryopsidaceae
2—Caulerpaceae
3—Halicystaceae
4—Codiaceae
5—Derbesiaceae
6—Vaucheriaceae
7—Phyllosiphonaceae

Order 11—Siphonocladiales
Family 1—Valoniaceae
2—Dasycladaceae
Class 2—Charophytaceae
Order—Charales
Family—Characeae

II. EUGLENOPHYTA

Class—Euglenales
Order 1—Euglenales
Family—Euglenaceae
Order 2—Colaciales (Euglenocapsales)
Family—Colaciaceae

III. PYROPHYTA

Class 1—Cryptophyceae

Order—Cryptophycales

Family—Cryptaphyceae

Class 2—Dasmokontae

Class 3—Dinophyceae

Order 1—Gymnodiniales

2—Peridiniales

3—Dinophysidales

4—Rhizodiniales

5—Dinocapsales

6—Dinotrichales

7—Dinococcales

IV. CHRYSOPHYTA

Class 1—Xanthophyceae

Order 1—Heterochloridales

2—Rhizochloridales

3—Heterocapsales

4—Heterotrichales

5—Heterococcales

Class 2—Chrysophyceae

Order 1—Chyrsomonadales

Sub-order 1—Cromulineae

Sub-order 2—Isochrysidineae

Sub-order 3—Ochromonadineae

Order 2—Rhizochrysidales

3—Chrysocapsales

4—Chrysotrichales

5—Chrysosphaerales

Class 3—Bacillariophyceae

Order 1—Centrales

2—Pennales

Very simple among the Green algae are the Volvocale. They may be unicellular or multicellular, coenobial or filamentous. Several species of Volvocales are known to occur in Maharashtra. They grow in fresh water ponds, tanks, rivers, temporary pools, below cascades, on moist soil or in marine waters. Apte (1936) has described *Volvox cartari*, *V. poonaensis* from Pune and Purandar.

The marine forms are large and multicellular. Unfortunately in Maharashtra even a complete check-list of fresh water algae is not available. It is extremely difficult therefore to put even an approximate number of genera and species of fresh water algae with confidence. The one prepared and described by K. P. Biswas (1949), for India is the only list available, though incomplete and out of date at present. There are 11 Orders of the Green algae. Very simple among these are the (1) Euglenales, (2) Volvocales, (3) Unicellular Chroococcales, Charales are highly evolved.

1. Chlorophyta

Chlorophyta are Green Algae having the same pigments as in higher plants. Their classification by West (1916), Fritsch (1948) and Smith (1938) is largely followed.

West (1916) has recognized four primary divisions of Chlorophyceae. (1) Isokontae, (2) Heterokontae, (3) Akontae, and (4) Stephnokontae. Fritsch (1944) however, recognises 11 classes of algae. The Chlorophyceae is the first one in his System. Chlorophyceae (Isokontae) comprises families Volvocaceae, Hydrodictyaceae, Chlorellaceae, Scenedesmaceae, Ulorotrichaceae, Trentepholiceae, Cladophoraceae, Oedogoniaceae, Vauchariaceae, Conjugateae or family Zygnemataceae, Desmidiaceae and Characeae.

Xanthophyceae (Heterokontae) constitute the second group of the Chlorophyceae. It includes families Tribonamaceae, Botrydiaccae. The third group comprises the family Bacillariophyceae or Diatomaceae, the fourth Dinophyceae and the fifth Euglenaceae.

Since different authors follow different systems, the one by Fritsch (1944) and Smith (1938) would largely be followed here. A number of papers on different members by workers like Majeed, Allen, Bharadwaj, Biswas, Boergessen, Bruhl, Carter, Dixit, Ghose, Iyengar, Hobson, Mitra, Parukutti, Ramnathan, Randhawa, C. B. Rao, R. N. Singh, Thivy, Apte, Gonzalves, Kamat, Gandhi etc., have appeared. However, there is no consolidated list of green algae in India. Only monographs dealing with Cyanophyta by Deshikachari (1959) and Zygnamatales by Randhawa (1959), Characeae by Pal et al (1962) are available. The lists given here therefore should not be considered as complete. It is only indicative of the wide range of the members of different families of this group that occur in India due to variety of habitats. They demand further investigation.

Professor M. O. P. Iyengar (1928) has described and added largely to our knowledge of this taxon. Family Volvocales in Bombay Presidency has been described by Apte (1936). A very characteristic Algae of India *Drapanaldiopsis indica,* has been described by Y. Bharadwaj (1938) and Mitra (1943), and the second, *Fritschiella tuberosa,* by Iyengar (1932) and R. N. Singh (1941). Since then much work has been done on the cytology of algae in the Botany Department of the Banaras University by Sharma (1971) and others at Madras University and at Poona University and Institute of Science, Bombay; but there is no composite account of them. Therefore, only the selected members have been mentioned below.

Family I Volvocaceae—Apte (1936) has described *Volvox dissipatrix* Shaw, *Volvox prolificus* Iyengar, *Volvox carteri* Stein (*V. globator* Stein), *Volvox poonaensis* Apte. *Volvox carteri* occurs also in Bombay and *Volvox poonaensis* in Poona. Some other species are common throughout the State.

Family II. Chlorococcaceae for India have been described by Iyengar (1920). The common genus is *Chlorococcusm.*

Family III. Ulotrichaceae—*Ulothrix zonata.* common.

Family IV. Cladophoraceae—In this family marine and fresh water forms are found, more fresh water than marine. The common members such as *Cladophora glomerata*, *Chaetomorpha*, *Rhizoclonium* are common. In fresh water *Cladophora crispata*, *Pithophora sp.* *Cladophora* and *Pithophora* have both fresh water and marine species.

Family V. Chaetophoraceae—Common genera are *Chaetophora* and *Pleurococcus*.

Family VI. Oedogoniaceae.

A large number of species both monoeceous and dioeceous occur in the country. But they have not been monographed. Of the other two genera, *Bulbochaete* is known to occur in moving river like Mutha and streams ; and *Oedocladium* on moist soil at hill stations. *Bulbochaete elatior* is common in many fresh water streams and rivers. The common species of *Oedogonium* are *Oedogonium terrestris*, *Oedogonium sociale*, and *Oedogonium oblongatum*. Of these three genera, *Oedocladium* is rare. This interesting alga is found generally at hill stations above 3000′ altitude.

In *Conjugateae or Zygnemaceae* the common genera are (1) *Debarya*, (2) *Temnogamatum*, (3) *Mougeotia*, (4) *Gonatonama*, (5) *Zygnema*, (6) *Zygogonium*, (7) *Pleurodiscus*, (8) *Pyxispora*, (9) *Spirogyra*, (10) *Sirogonium*, (11) *Gonatozygae*, (12) *Spirotaenia*, (13) *Closterium*, (14) *Cosmarium*. *Temnogametum* is very rare.

The members of this family occur generally in the post monsoon period in ponds or rivers, in which they grow till summer. They grow through winter and sometimes in spring and sprout again from zygospores, aplanospores, or akinetes next rainy season. A few are ephemeral, e. g. *Mougeotia sphaerocarpa*, *Spirogyra daedalea*. They propagate by spores throughout the year. The following Table No. II-1 shows species which generally occur in Maharashtra and Western India :

TABLE No. II-1

Name (1)	Habitat (2)	Remark (3)
Family Mougeotiacea		
1. *Debarya jogensis* Iyengar ..	Known from Saravati falls in rock-pools in the bed of river of Saravati River above Raj falls (Karnatak).	
2. *Temnogametum indicum* ..	In Nal *sarowar* in Western Gujarat in rocky pools, but unknown as far in Maharashtra.	
Family Zygnemacaceae		
3. *Zygnemopsis saravatiensis* Iyengar. ..	Above Jog falls in rocky pools in the beds of Saravati river (Karnatak). Not known in Maharashtra.	
Zygnema stellinum (Vaucher) Agardh.	Free floating in the beds of river and rocky pools, Bombay, Pune, Nasik.	
Zygogonium hansgirgii (Schmidle) Transeau. ..	Igatpuri either terrestrial or sub-aerial—generally near water streams.	
Zygogonium aricetonum Kutz. ..	Western ghats on laterite soils on hill slopes and open ground.	

TABLE No. II—1—*contd.*

Name (1)	Habitat (2)	Remark (3)
4. Family Spirogyraceae		
Spirogyra microspora Jao ..	Ghatkopar, Bombay.	
Spirogyra indica Krieger ..	Central Provinces	
Spirogyra rivularis (Hassoll) Rabenhorts.	In running water near Kanheri Caves, Bombay.	
Spirogyra turtusa Gay ..	In puddles at Vile Parle, Bombay	
Spirogyra hymerae Britton and Smith.	Puddles at Khar, Bombay.	
Spirogyra ellipsospora .. Transeau.	Streams near National Park, Bombay, Kanheri caves.	
Spirogyra triplicata (Collins) Transeau.	In a pond at Khar, Bombay.	
Spirogyra punctulata Jao ..	In a stream near National Park, Bombay.	
Spirogyra dictyospora Jao ..	In a stream near Borivli.	
Spirogyra ori ntalis W. and G. S. West.	In a stream near Dahisar, Bombay.	
Spirogyra braziliensis .. (Nordst) Transeau.	In puddles at Goregaon, Bombay.	
Spirogyra quadriaminata Jao	In a pond near a temple at Thane, Bombay.	
Spirogyra rhizobrachiatis Jao	Near a streamlet near Kanheri caves, Bombay.	
Spirogyra minor (Schmidle) Transeau.	In a puddle at Vile Parle, Bombay.	
Spirogyra verrucasa (Jao) Krieger.	Central Provinces.	
Spirogyra apuiata Jao ..	In a puddle at Koliwada, Bombay.	
Spirogyra majuscuia Kutzing	In a puddle at Koliwada, Bombay.	
Spirogyra punctiformis .. Transeau.	In a puddle at Goregaon, Bombay.	
Spirogyra micropunctata .. Transeau.	Streams at Borivli.	
Spirogyra arta Jao	Bombay.	
Spirogyra tumida Jao ..	In a puddle at Goregaon.	
Spirogyra denticulata .. Transeau.	In a pool at Andheri, Bombay.	
Spirogyra kuusamoensis Hirn	Bombay.	
Spirogyra graviileana .. (Hassali) Kutzing.	Dahisar, Bombay.	

TABLE No. II—1—*contd.*

Name (1)	Habitat (2)	Remark (3)
Spirogyra faoi Ley ..	In a pool at Andheri, Bombay.	
Spirogyra inconstans Collins ..	In a streamlet near Kanheri caves, Borivli, Bombay.	
Spirogyra moebti Transeau ..	Bombay.	
Sirogonium ceylanicum Wittrock. ..	In rainwater pools in Bombay.	
Sirocladium Maharashtranse Randhawa. ..	Terrestrial on wet fields at Khandala, Katraj, Western ghats, Bombay.	
Family Ulvaceae*		
6. *Enteromorpha flexuosa* (Wolf). ..	Bombay.	Marine.
Enteromorpha tubulosa Kutz ..	Bombay.	
Enteromorpha prolifera (Fl. Dan.) J. Ag. ..	Bombay.	Marine.
7. *Ulva lactuca* L.	Bombay.	Marine.
Ulva reticulata Forssk ..	Bombay.	Marine.
Family Boodleaceae*		
8. *Cladophoropsis zollingeri* (Kutz) Boergs. ..	Bombay.	Marine.
Cladophoropsis sundanansis Reinbold. ..	Bombay.	Marine.
Family Cladophoraceae		
9. *Rhizoclonium kochianum* Kuetz. ..	Bombay.	
Rhizoclonium grande Boergs ..	Bombay.	
10. *Chaetomorpha indica* Kuetz ..	Bombay.	
Chaetomorpha Linoides (Ag.) Kuetz. ..	Bombay.	
Chaetomorpha aerea (Dillwa) Kuetz. ..	Bombay.	
Chaetomorpha antenulana (Fory) Kuetz. ..	Bombay.	
Chaetomorpha clavata (Ag.) Kuetz. ..	Bombay.	
11. *Lola* (?) *capillaris* (Kuetz.) A. et G. Hamel.	Bombay.	
12. *Cladophora saracenica* Boerga	Bombay.	
Cladophora colaxbense Boergs	Bombay.	

TABLE No. II—1—*contd.*

Name (1)	Habitat (2)	Remark (3)
Cladophora bombayensis Boergs. ..	Bombay.	Marine.
Cladophora monumentalis Boergs. ..	Bombay.	Marine.
Family Dasycladiaceae Boergs		
13. **Acetabularia calyculus* Quoit et Gaimard.	Bombay.	Marine.
Family Siphonocladaceae		
14. *Struves delicatula* Kuetz ..	Bombay.	
Family Bryoesidaceae		
15. *Pseudobryopsis mucronata* ..	Bombay.	
Family Caulerpaceae		
16. *Caulerpa fastigiata* Mont.; ..	Bombay.	Marine.
Caulerpa scaepelliformis var. *intermedia*, Web.	Bombay.	Marine.
Caulerpa racemosa (Forsk) Web. V. Bose.	Bombay.	Marine.
Caulerpa peltata Lamour ..	Bombay.	Marine.
Family Vaucheriaceae		
17. *Vaucheria piloboeoides* Thur	Bombay.	

*These are marine.

The affinities and the inclusion of some genera of green algae in one family or the other is often controversial.

In Eugienales *Euglena* and *Chlamystomonas* are the chief representatives of unicellular Green algae. They have colourless or green coloured protoplasts. Euglenales are taken by some as a separate Order of the Chlorgphyta called Euglenophyta, Family—Euglenaceae. Similarly the Dinoflagellates are considered to be members of animal kingdom by the zoologists, and as plants by the botanists. Their fossils occur in the Tertiary oilbearing strata in Gujarat. The diatoms are also green coloured unicellular organisms. They are put in a separate group Bascillariophyta, family Bascillariaceae. They have lamillate protoplast with one or more pyrenoid bodies. Their cell wall is highly silicified. It presents numerous patterns which make their identification and classification easy. They are of two types : the Centrales and Pinnatales, or Pinnales.

Another conspicuous group in fresh water is the Charales characterised by erect branched thallus divided into nodes and internodes. The branches with limited growth—the so-called 'leaves' form a whorl at each node. They bear either one-celled solitary oogonium surrounded by a sheath of spirally arranged sterile cells at a node. Antheridia

also are one-celled, but are united in uniseriate filaments surrounded by a common round envelope of 8-celled manubrium around a stalk. There are 6 genera and 85 species of Charales. Some species of past Charales have been found in the Deccan Intertrappean Series and are recognised by the spirally covered outer cells on the oogonium or the nucule. They are called '*Gyrogonites*'. About a dozen species of them have been recognized. The other two genera have rather smooth walls and are small plants. They are known as *Nitella* and *Lamprothamnium*. The former only occurs in Maharashtra. Charales prefer clear aerated water.

Charophyta in Maharashtra

The Charophyta are represented by two genera, *Nitella* and *Chara* in Maharashtra. They have been mainly studied by S. C. Dixit (1935, 1940, 1942). The chart below shows the species occurring commonly. A careful and intensive search if made in Western Ghats may yield some more.

They also occur in fossils in Deccan Intertrappean beds at Sansar and other places. This shows the great antiquity of this group in Maharashtra.

List of Charophyta in Western India

Genus Nitella—

1. *N. apaca* Agardh
2. *N. acuminata* Braun
3. *N. stellaris* Allen T. F. Dixit.
4. *N. dualis* Nordstadt
5. *N. confervacea* A. Braun
6. *N. oligospira* Braun
7. *N. furcata* Agardh
8. *N. mucronata* (Br.) Muquel
9. *N. tenuissima* (Desv.) Kutz var. *bryssoides* Braun
10. *N. translucens* Agardh
11. *N. hyalina* (DC) Agardh

Genus Chara—

1. *C. corallina* Willdenov
2. *C. brauni* Gmelin
3. *C. contraria* Kutz.
4. *C. succinata* Braun
5. *C. nuda* Pal var. *Kolhapurensis* Dixit
6. *C. fibrosa* Agardh
7. *C. hatei* Dixit
8. *C. contraris* Kuetz
9. *C. vulgaris* Linn.
10. *C. globularis* Thailler
11. *C. brachypus* Braun
12. *C. zexlanica* Willd.

2. BACILLARIOPHYTA

Fam. Bacillariophyceae or Diatomaceae

India is supposed to be rich in diatoms, both living and fossil. However they have not been fully worked out from most of the places. In this connection noteworthy work has been done on the diatoms of Andaman and Nicobar, Sri Lanka, Maldiv Islands, Cochin, Colebrooke Islands and Trivandrum on the Western Coast of India. Some fresh water diatoms have been reported from Karewa beds of Kashmir. Desikachary and Maheshwari (1958) have reported them from Colebrooke Islands. It seems that there are more fossil diatoms than living ones in India. 230 species belonging to 57 genera are known in fossils in India ; whereas only 27 species belonging to 14 genera of marine diatoms are known. Fresh water diatoms are known mostly from Kashmir, Bengal and Assam. Of the fresh water diatoms 80 to 85 per cent belong to Pinnales, whereas Centrales are rather poorly represented. The principal genera among the fresh water diatoms are *Melosira, Fragilaria, Caloneis, Stauroneis, Pinnularia, Cymbella, Epithemia Navicula, Synedra, Amphipleura, Cymatopleura, Gomphonema, Nitz sha, Pleurosigma, Rhoiccsphenia, Rhopalodia, Surirella, Cyclotelia and Aimphora.*

Majority of the fresh water diatoms are from the deposits where fresh water conditions once prevailed, but some had been also growing in brackish and marine waters. *Cocconeis, Epithermia, Nitzschia, Navicula Cymbella* grow in fresh as well as brackish water ; on the other hand *Coscinodiscus* and *Cyclotella* grow in brackish as well as marine water. None of the Mesozoic diatoms had a raphe or speudoraphe ; therefore, it is presumed that the ancestors of the diatoms might have been discoid, or cylindrical organisms (Wordnardt, 1972).

Marine diatoms are abundant on the coast of Colebrooke, Andaman and Nicobar Islands. They have extensive deposits of marine fossil diatoms, especially throughout Nicobar Islands in the Miocene strata. Fresh water fossil diatoms are known from Inter-glacial deposits of the Lower Karewas of Kashmir. In the Neogene flora diatoms belonging to the Centrales are abundant. In the Pleistoncene of India more of Pinnales with raphe, as in the genus *Navicula, Nitzschia, Cymbella,* are found. Most of the modern members of the Diatomaceae start appearing from the Middle of the Lower Miocene period. Many of them have continued through Pleiocene to Pleistocene to modern times ; some have still living members.

Principal fossil genera among Pinnate diatoms are *Amphiphleura, Caloneis, Denticula, Navicula, Plagigramma, Rhephoneis, Stauroneis.*

Among Centrales genera *Actinocyclus, Camphyloneis, Melosira, Stephanodiscus, Triceratium* are common. However, certain genera have become extinct in Pliocene or Pleistocene. These are *Auliscus, Camphylonsis, Endictya, Eupodiscus, Gephyria, Glyphodesmis, Rossiella, Triceratium, Rhaphoneis, Rhoicosphenies* and *Disploneis.* It should be remembered that much of the oil from Cambay Basin and other places in Gujarat and elsewhere in India, belong to the Miocene period, and hence the occurrence of certain genera of diatoms in large proportion is of considerable significance in oil prospecting. About twelve genera of fossil diatoms have been found in the tufaecous deposits on the banks of Mula river at Kotur in Ahmednagar district.

3. PHAEOPHYTA

The next group of the algae is generally recognised as the Phaeophyta or Brown Algae. The photosynthetic pigment in them the chlorophyll is masked by the golden brown pigment called Fucoxanthin. They are all marine plants. The classification is as follows :—

Class 1. Isogeneratae			
Order	..	1	Ectocarpales
		2	Sphaecelariales
		3	Tilopteridales
		4	Cutleriales
		5	Dictyotales
Class 2. Heterogeneratae			
Sub Class	..	1	Haplostichineae
Order	..	1	Chordariales
		2	Sporochnales
		3	Desmarestiales
Sub-class	..	2	Polystichineae
Order	..	1	Punctariales
		2	Dictyosiphonales
		3	Laminariales
Class 3. Cyclosporeae			
Order	...	1	Fucales

They are all large multicellular plants having zygospores. Gametes have two unequal cilia. About 190 genera and 900 species constitute this sub-class. Some of them grow in hot waters of Mediterranean Sea others in Tropical seas and still others grow attached to sub-strata by holdfasts in cold waters. Some are epiphytes and a few are endophytes They show marked distribution of forms in warm and cold waters. *Sargassum*, *Dictyota*, *Laminaria* are typical hot water plants, whereas *Fucus* grows mostly in cold waters right upto Arctic seas. Most of them grow in the littoral zone, and often get exposed to air after high tide, being left over by the receding waters of the sea tide. Simple sugars, pentoses are manufactured by them and stored. They also store polysaccharides. Forms like *Laminaria* grow to a length of 20 to 25 meters and about 3 metres tall. The gametophyte and sporophyte generations at times look exactly alike. Many of them grow by a single apical cell-quite regularly.

The thalli of *Fucus* and *Lanmiaria* are differentiated into two distinct tissues, the central medulla of elongated colourless cells and cortex of isodiametric cells surrounding them. They have sexual mode of reproduction. The gametic fusion takes place either by isogamous motile gametes or by aniso-gametes in the cavities of the conceptacles. They are either male, female or hermaphrodite. They are divided into two main Orders :

(1) Ectocarpales—Thallus with branched filamentous and multicellular sporangia.

(2) Sphacaelarialles—The gametophyte produces many celled gametangia and unilocular sporangia. Fusion of gametesresults in producing two diploid generations in a life cycle, byt the sporophyte may be produced by neutral spores also.

The third Order of Pheophyta is Tilopteridales. It has trichothallic growth and free branches. The fourth Order Cutleriales has disc like thallus. The sporophyte produces unilocular sporangia. The fifth Order Dictyotales is characterized by erect, flat, pseudo-parenchymatous thallus which grows by means of a single apical cell. The sexual reproduction is by the liberation of egg. Fertilization is outside the body in water in the cavity of female or hermaphrodite conceptacle. The antheridia are many and liberate spermatozoides also in water.

Members of the other Orders Chordariales, Sporochnales, Desmarestiales, Punctariales, Dictyosiphonales, Fucales do not occur in Indian Sea Waters. The next large Orders are Laminariales, Dictyosiphonales, Chordariales. Of these, the Laminariales are the source of iodine. They are marine.

The Brown algae are often drifted to long distances and are collected for the various chemical substances such as iodine, gellatin, algenic acid, algates etc. which are of economic use. Theoretically they are the members of the littoral zone. They colonised land first and formed colonies, as such they are the pioneers in making land as their Habitat. Church (1898) has based his theory of Transmigration of water plants to land. Bower (1908, 1924) has traced the Origin of Land Flora to such coastal dwellers which were left on the moist coastal land surface during low tide and flooded back to water by sweeping high tide twice every day. They are supposed to have developed adaptations to sub-aerial life on land, dry or semi-aerial on land. This led to Land Habit.

The drift brought on the shore by the high tide, when available in bulk, forms the source of economic materials from sea algae. It is, however, not available in large bulk on the sea coast of Maharashtra as at Okha in Saurashtra or Tuticorin in Tamil Nadu.

3. Phaeophyta occurring in Maharashtra

Phaeophyta are not a large group in Maharashtra like the Chlorophyta. They contain yellow pigment phycoxanthin and phycobillin. Although they are economically important, they do not occur everywhere. They are marine forms growing either in temperate or tropical waters. The following list of Brown Algae of Bombay coast has been compiled mainly with the help of Dixit (1964) and the check list of Marine Algae by Krishnamurthy and Joshi (1978) . They are all marine. The list of common members of Phaeophyta that occur at Bombay and at a few other places is given below. Total members so far known is 20. They are all marine. *Fucus* is not found on Maharashtra coast.

TABLE No. II-2

Name (1)	Habitat (2)	Remark (3)
1. *Ectocarpus mitcheliae* Harv.	..	All these are marine plants growing in ponds by sea side and estuaries.
2. *Sphacaleria furcigera* Kutz.	..	
3. *Dictyopteris acrostichoides* .. J. Ag.	..	
4. *Dictyota bartayrasiana* .. Lamour.	..	

TABLE No. II-2—*contd.*

Name (1)	Habitat (2)	Remark (3)
5. *Dlctyota dumoss* Boerg ..		
6. *Dictyota maxima* Zan. ..		
7. *Dictyota atomaria* Hauck. ..		
8. *Dlctyota pinnatifida* Kuetz.		
9. *Dilophus fasciola* (Roth) Howe.		
10. *Spathoglossum asperum* J. Ag.		
11. *Steochospermum marginatum* (Ag.) Kuetz.		
12. *Padina tetrastromatica* Hauck.		
13. *Myrtactula arabica* (Kuetz) Foldm.		
14. *Nemacystus desipiens* (Sur.) Kuck.		
15. *Colpomenia sinuosa* (*Roth.*) Derb. et. Sol.		
16. *Sargassum tenerrimum* J. Ag.		
17. *Sargassum ilicifolium* (Turn.) Ag.		
Var. *venusta* Grun.		
18. *Sargassum glaucescens* ..	Vengurla.	
19. *Sargassum marginatum* ..	Bombay.	
Summary of Phaeophytaen in Maharashtra.	Bombay.	
Family Ectocarpaceae		
1. Genus : *Ectocarpus* ..	..	1 sp.
Family Sphacelariaceae		
2. Genus *Sphacalaria*	..	1 sp.
Family Dictyotacae		
3. Genus *Dictyopteris*	..	1 sp.
4. Genus *Dictyota*	..	5 sp.
5. Genus *Ditophus*	..	1 sp.
6. Genus *Spathoglossum* ..	..	2 sp.
7. Genus *Stoechospermum* ..	..	1 sp.
8. Genus *Zonaria*	..	1 sp.
9. Genus *Padina*	..	1 sp.

TABLE No. II-2—*contd.*

Name (1)	Habitat (2)	Remarks (3)
Family Chardariaceae		
10. Genus *Myriogloea*	..	1 sp.
Family Corynophlaeaceae		
11. Genus *Myriactula*	..	1 sp.
Family Spermatochnaceae		
12. Genus *Nemacystus* ..	..	1 sp.
Family Punctariaceae		
13. *Genus Rosenvingea* ..	..	1 sp.
14. Genus *Colpomenia*	..	1 sp.
Family Sargassaceae		
15. Genus *Sargassum*	..	2 sps.
	Total Genera 15 and Species 20	

4. RHODOPHYTA :

Rhodophyta are the red coloured algae. They have a red pigment, Phycoerythm in addition to chlorophyl, and phycocyanin, the blue pigment. The red pigment being more in quantity if masks the other pigments. Barring a few exceptions most of them are marine algae. They contain 400 genera and 2500 species. About a dozen occur as fresh water forms, which generally live in well aerated waters of rapid cascades, falls, and such other swiftly flowing streams. Marine species occur in all oceans upto Arctic and Antarctic. Their distribution is co-related with the surface temperature of sea water. They also show vertical distribution according to temperature of water layers in intertidal zone. They grow sometimes about 2 to 200 metres in height or depth. They grow rooted intimately to the rocks or other inanimate objects. Some grow even epiphytically, others parasitically. But as a rule they are autotrophic. They have a single stellate chromatophore which stores naked pyrenoides which do not have starch sheath as in the Chlorophyceae. The chromatophores may also be disci-form. The starch formed is in the form of small solubel grains and is called Floridean starch. It is soluble in water. Most of the genera have multicellular branched or simple thallus. They propagate vegetatively by fragmentation or by means of carpospores.

The reproductive organs are borne on separate branches. Archegonium-like female sex organ is called carpogonium. It has one-celled trichogyne. The male reproductive organ is called antheridium or spermatangium and contains a single non-flagellate male gamete, the spermatium. Fertilization is effected by spermatium entering the trichogyne. The zygote forms a carpogonial body which divides into sixteen carpospores. Each carpospore forms a new plant.

Red Algae are divided into two sub-classes, Bangiales and Florideales. Their classification is as follows :—

VII. *Rhodophyta*

Class	Rhodophyceae
Sub-class I	Bangiodeae
Order	Bangiales
Sub-class 2	Florideae
Order	1 Nemalionales
	2 Gelidiales
	3 Cryptonemiales
	4 Gigartinales
	5 Rhodymeniales
	6 Ceramiales

In India about 90 genera and 123 species have been recorded. Of these, the species of *Gracilaria* and *Gelidium* form the main source of agar-agar. The two fresh water members of Red Algae are also known. They are *Batrachospermum* and *Nemalion*. Of these *Batrachospermum* is common in rapid flowing water of hill streams in Assam, Darjeeling, Lonavla and in some streams in the Western Ghats at several places like Dharwar, Honavar, Goa, etc. *Nemalion* does not occur in India.

The coastal algae of Maharashtra were surveyed by the famous Swedish Algologist Boergassan, and later by S. C. Dixit and by the members of the Central Salt and Marine Chemicals Research Laboratory at Bhavnagar, Dr. Thiwy, Krishnamurthy and Joshi. Stray references to them are also found in the works of De Toni, S. C. Dixit and others. The list given here is a combined list of marine Red algae based on the works of Boergessen (1930), Dixit (1964) and Krishnamurthy and Joshi (1970). Red algae are a very ancient group and are supposed to be related to Rust Fungi. They date as far back as Ordovician. The fossil members of Red Algae belong to the most advanced groups among them. The common genera found at Bombay and other places on west coast of India are given in the list of Marine algae on pp. (80-86) in the list of Algae of Bombay.

5. Cyanophyta

Cynophyta or Blue green algae, also called Myxophyceae, occur as gelatinous masses of various shapes, floating in water or growing in bits on moist surfaces. They occur generally in groups and seldom as single cells. They do not possess organised nucleus or central vacuole. The gelatinous material secreted by their protoplast forms a sheath around them. They multiply by fragmentation or by cyst-formation. They live in fresh water and sometimes form ' Water Blooms'. They are found on damp soil, rocks, ledges, bark of trees with dripping water. They can grow below the surface of soil about a metre or form a thin coating on it. They are essentially colonial forms and can grow at any temperature 40-75°C in hot water springs.

They are branched or grouped in gelatinous sheath or they occur as chains of individual cells. They contain a pigment called Phycocyanian, and also a red pigment similar to Phycoerythrin. The pigments are

diffused in protoplasm. Since they have no nucleus, their genes are distributed in plasma. The vegetative reproduction is by means of fragmentation, isolation, or by the formation of heterocysts and hormogones. There is no sexual reproduction. No flagellata gametes or zoospores have been found in them. Akinetes or cyst-formation is common. They are a very ancient group and are capable of surviving under the most trying extreme conditions. They are susceptible to viral attacks. Some of them have the capacity to fix atmospheric Nitrogen, *e. g.* Blue Green algae growing in rice fields. They have been divided in three Orders depending upon the filamentous or non-filamentous nature of the thallus and mode of reproduction.

1. *Chroococcales.*—These are Colonial forms which multiply by vegetative cell division and fragmentation of colonies. There are 35 genera and 250 species all fresh water.

2. *Chamaesiphonales.*—These grow epiphytically, singly or gregariously or in colonies. They form endospores.

3. *Hormogoniales.*—They are filamentous forms with whip-like trichomes having united cells. They multiply by akinete formation or heterocysts or hormogones. About 90 genera and a thousand species are found. In India they have been surveyed by Desikachari (1969), Singh (1939), Gonsalves and Kamat (1954), Kamat (1961-62) etc. Their list in Maharashtra so far known is given in the following Table II-3.

TABLE No. II-3

Cyanophyta of Maharashtra

Name (1)	Habitat (2)	Remark (3)
1. Family Chroococcaceae Nageli		
Microcystis aeruginosa flavirid is Golankin. ..	Found occasionally in distant lakes	..
Microcystis aeruginosa Kuetz.	Common in many stagnant lakes, Igatpuri, Bombay.	
Microcystis flosaquae (Wittn) Krichnar.	Common in inland ponds.	
Microcystis stagnalis Lemm	In a tank at Bandra.	
Microcystis insignia (Beck) Desikachari.	In Bombay, on surface of a tank.	
2. *Chroococcus turgidus* (Kuetz) Nag.	A planktonic form often seen with mangroves submerged or on sub-aerial part of tree trunk.	
3. *Chroococcus schiz oder-maticus* West. ..	In paddy fields at Dahisar, Bombay.	
Chroococcus hansigirgi Schmidle. ..	On moluscan shells in a lake, Pune.	
Chroococcus paidus Nag ..	Igatpuri, Borivli, Jogeshwari caves near Bombay, on stone walls at Mahabaleshwar.	

TABLE No. II-3—*contd.*

Name (1)	Habitat (2)	Remark (3)
4. *Glosocapsa strata* (Turp) Kuetz.	A blackish mucilaginous crystaceous alga.	
Gloeocapsa crepidinum Thuret. ..	Crust forming Alga, Pune.	
Gloeocapsa violacea (Corda) Rabenh.	Igatpuri.	
Gloeocapsa granosa (Berk) Kuetz.	Found in hot water springs at Vajreshwari growing at a temperature 34° C.	
5. *Aphanocupsa littoralis* Hansg.	Sea shore near Chowpati, Bombay.	
A. macrococca Hansg. ..	Bombay.	
Aphanocapsa pulchra (Kuetz.) Rabenh.	In salt pans near Dadar.	
Aphanocapsa elachista *West* G. S. West. var. *Conferta* W. et. G. S. West.	In a tank at Bandra, Bombay.	
Aphanocapsa thermalis (Kuetz) Brugg.	In hot water springs at Vajreshwari near Bombay.	
6. *Aphanothece conferta* Richter	Found in cultures of soil at Thane and Goregaon.	
Aphanothece castagnei (Breb.) Rabenh.	Forms scum on the surface of ponds or grows epiphytically, Borivli.	
Aphanotheca pallida (Kuetz). Rabenh.	In paddy fields or floating free in ponds.	
Aphanotheca pallida var *minor* Dixit.	In the bed of stagnant rivulets near Santacruz and Kurla.	
7. *Coelosphaerium* Nag ..	In rain water ponds at Jogeshwari caves, Bombay.	
8. *Merismopedia minima* Beck	Forms small colonies on the surface of water.	
Merismopedia glauca (Ehrenb.) Nag. ..	In fast running streams, shallow pools, mangrove swamps, Bombay.	
Family Entophysalidaceae Geitler.		
9. *Chamaesiphon fuscus* (Rostaf.) Hansg. ..	Danger point, Bombay.	
Family Hyellaceae Borzi.		
10. *Scopulonema concharum* (Hansg.) Geitler.		
Family Oscillatoriaceae Krichner.		
11. *Spirulina subsalsa* Oerstd ..	In hot water springs at Vajreshwari, Bombay, Near Colaba seashore, Bombay.	
Spirulina major Kuetz ..	Bandra, Bombay. In stagnant salt pan waters.	

TABLE No. II-3—*contd.*

Name (1)	Habitat (2)	Remark (3)
12. *Oscillatoria sancta* (Kuetz.) Gomont.	In rain water pools at Dharavi road and Mahim, Bombay.	
Oscillatoria subbrevis Schmidle F. *crassa* Dixit. ..	Rain water pools at Borivli also on moist soil at Borivli.	
Oscillatoria anquina (Bory) Gomont.	In paddy field soils at Goregaon Bombay.	
Oscillatoria proboscidea Gomont. ..	Dahisar, In hot water springs at Vajreshwari at 38 °C.	
Oscillatoria chalybea (Martens) Gomont. ..	Bombay.	
Oscillatoria Jasorvensis Vouk	In hot springs at Vajreshwari.	
Oscillatoria tenuis Ag. ex. Gomont.	Bombay.	
Oscillatoria irriqua Kuetz ..	On moist soil, Bombay.	
Oscillatoria gloiophila Gomont.	.. Bandra tank, Bombay.	
Oscillatoria schultzii Lemm ..	Paddy fields at Thane.	
Oscillatoria formosa Bory ..	In tanks, salt lake filters, lakes at Bombay.	
Oscillatoria animalis Ag. V. *tenuior* Stockmeyer.	In paddy fields at Dahisar, Goregaon, Bombay.	
Oscillatoria acuminata Gomont. ..	..	
Oscillatoria serpentina Richler. ..	In Western ghats, Pune.	
13. *Porphyrosinhon notarisii* (Manegh.) Kuetz. ..	On moist soil or fresh water Bombay. In rice fields also.	
14. *Phormidium africanum* Lemm.	In hot springs at Vajreshwari near Bombay at 40 to 50°C. The Bombay-Algae differs much from the type having broader diameter.	
Phormidium foveolarum Gomont. ..	On moist soil in rice and wheat fields in Goregaon, Dahisar, Khandala, Lonavla.	
Phormidium jenkelianum Schmid. ..	In paddy fields moist walls of drains, Thane.	
Phormidium valderienum (Delp) Gomont. ..	Water logged soi at the bottom of pools. Paddy fields at Dadar, also Mahabaleshwar.	
Phormodium ratzii (Ag.) Gomont. ..	On rocks near streams or on submerged objects. Parel near Bombay.	
Phormidium inundatum Kuetzing. ..	On walls with fresh water dripping on them.	
Phormidium sp. Schmidle ..	On tree trunks at Pune and Bombay.	

TABLE No. II-3—*contd.*

Name (1)	Habitat (2)	Remark (3)
15. *Lyngbya inflexa* Fremy ..	Bandra.	
Lyngbya cryptovaginata Schkorbatow. ..	In rain water pools inside the caves at Jogeshwari.	
Lyngbya aestuarii Liebm ..	In planktonic lakes growing epiphytic on sponges. Dadar, Parel, Mahalaxmi. Matunga.	
F. spectabilis Gom	Occurs in hot water springs at Vajreshwari at 34-36°C.	
Lyngbya erabi W. et. G. S. West.	On mud and stone walls submerged in flowing water at Borivli.	
Lyngbya allorgei Fremy ..	On mud and stone walls submerged in floating water at Borivli.	
Lingbya putealis Mont ex. Gomont.	In hot water springs at Vajreshwari at 40-45°C temperature.	
16. *Schizothrix aranaria* (Berk) Gomont.	Paddy fields at Thane, Goregaon, Dahisar.	
Schizothrix tenuis Woronichin. ..	In paddy fields soil culture, Khandala.	
Schizothrix lamyi Gomont ..	At Panchgani.	
17. *Sirocoleus kurzii* (Zeller) Gomont.	This genus occurs on large marie Algae and submerged roots of Rhizophora at Bandra seaface and Malbar Hill.	
18. *Microcoleus ehthonoplastes* Thur. ..	Bandra seaface, Dadar, Bombay.	
19. *Hydrocoleum meneghinianum* Kuetz. ..	Bombay.	
Hydrocoleum heterotrichum Kuetz. ..	Parel, Matunga in Bombay.	
Family Nostocaceae Kuetzing Subfamily Anabaenae.		
20. *Anabaenopsis* sp.	Common.	
21. *Cylindrospermum licheniforme* (Bory) Kuetz. var. *langispora* Dixit.	Mahalaxmi point.	
22. *Nostoc punctiforme* (Kuetz.) Hariot.	Bombay.	
Nostoc linckia (Raoth) Boret ex. Born at Flah.	..	
Nostoc humifusum Carmichael.	Paddy fields soil at Khandala and Lonavla.	

TABLE No. 11-3—*contd.*

Name (1)	Habitat (2)	Remark (3)
Nostoc calcicola Bre'b ..	On moist soil at Panchgani and paddy field soil at Dahisar, Goregaon and Thane.	
Nostoc muscorum Ag. ..	Paddy fields near Thane.	
Nostoc commune Vaucher ..	In stagnant water, moist rocks on soils at Neral.	
Nostoc microscopicum Carm	Epiphytic and on moist surface at Matheran.	
Nostoc hatei Dixit	On water plants in stagnant pools at Santacruz, Bombay.	
23. *Anabaena sphaerica* Bonet at Flah.	In fresh water ponds near Dadar.	
Anabaena fertilissima Rao C. B.	Bandra Tank, Bombay.	
Anabaena gelatinicola Ghose	In ponds and tanks at Borivli and Bandra.	
Anabaena beckii De Toni ..	In marshes near Bombay.	
Anabaena orientalis Dixit ..	Rain water pools at Mahalaxmi near sea coast and in hot water springs at Vajreshwari.	
Anabaena cacillarioides Bory	Rain water Borivli, Bombay.	
Anabaena hansgirgi Schmidle	On trees at Matheran.	
Anabaena voltzii Lemm.	..	
Anabaena bombayensis .. Gonzalves.	On the tank walls connecting hot springs at Vajreshwari.	
Anabaena laxa (Rabenh) .. A. Br.	In a lake at Pune.	
Anabaena inplexa Born. et. ex Flah.	In the bed of river at Borivli.	
Family Scytonemataceae		
24. *Plectonema hansgirgi* .. Schmidle.	On tree trunks at Matheran, in paddy fields at Thane.	
Plectonema gracillimum .. (Zopf) Hansgirg.	In hot water springs at Vajreshwari and paddy fields at Thane.	
25. *Scytonema javanicum* (Kuetz) Bornet.	On moist soils, Bombay.	
Scytonema hansgirgi .. Schmidle.	On the barks of trees around Pune.	
Scytonema hofmanni Ag. ..	Mahim, Igatpuri, Mahabaleshwar, Bombay, on stones, soils and trees.	
Scytonema tolypothrichoides Kuetzing.	Hot springs at Vajreshwari.	

TABLE No. II-3—*contd.*

Name (1)	Habitat (2)	Remark (3)
26. *Tolypothrix tenuis* (Kuetz.) Schmidle.	In moist soil and walls at Gavdevi.	
Tolypothrix distorta Kuetz ..	Bandra tank.	
Var. *penicillata* (Ag.) Lemm.	In stagnant ponds and rivulets at Borivli.	
Tolypothrix bouteillei (Bre'et Desm.) Forti. ..	Paddy fields near Goregaon.	
27. *Microchaete calothricoides* Hansgirg. ..	In paddy fields near Goregaon, Bombay.	
28. *Calothrix fusca* (Kuetz.) et. Flahault.	On dead tree trunks especially in pools of Matheran.	
Calothrix epiphytica W. et. G. S. West.	Bombay, on shells at Thane.	
Calothrix marchica Lemm. ..	In paddy fields, Bombay.	
29. *Dichothrix gypsophila* (Kuetz.) Born. et. Flah.	Igatpuri, rain water ponds at Bombay.	
Dichothrix baueriana (Kuetz.) Born. et. Flah.	Igatpuri and Matheran on tree trunks.	
Dichothrix orisiniana (Kuetz) Born. et. Flah.	Igatpuri and Matheran.	
30. *Rivularia hansgirgi* Schmidle	Between mosses growing on earth at Igatpuri.	
31. *Gloeotrichia indica* Schmidle	In lake at Igatpuri.	
Goeotrichia raciborskii Woloszynska. ..	Borivli, Bandra.	
Var. *bombayense* Dixit ..	Free floating in stagnant rivulets at Goregaon.	
Var. *conica* Dixit	Free floating or attached to *Chara zeylanica* at Santacruz.	
Family Nostochopsidaceae Gaitler.		
32. *Nostochopsis hansgirgi* Schmidle. ..	On rocks in rivulets at Goregaon.	
33. *Hapalosiphon baronii* W. et. G. S. West.	In lakes at Igatpuri.	
34. *Camptylonema indicum* Schmidle.: ..	On t.ee trunks at Mahim.	
35. *Stigonema ocellatum* (Dillw.) Thuret.	In paddy fields at Pune.	

Note.—This list is prepared with the help of Works of Dixit, Desikachari, Mrs. R. Gonzalves, Mrs. Marathe, Kamat and others.

TABLE No. II-4

6. MARINE ALGAE OF MAHARASHTRA AND WEST COAST OF INDIA

Name (1)	Habitat (2)	Remark (3)
CHLOROPHYTA CHLOROPHYCEAE ULVALES		
Family Ulvaceae		
Enteromorpha flaxuosa (Wulf). J. Ag. ..	Bombay, Dwarka. (Boergesen 1934, 35). Malwan harbour (Dixit, 1948).	
Enteromomorpha prolifera (Fl. Dan.) J. Ag. ..	Bombay (Boergesen, 1935).	
E. tubulosa Kuetz	Bombay.	
Ulva lactuca (L.) Le Jolis.	Bombay.	
U. reticulata Forssk	Bombay.	
CLADOPHORALES		
Family Cladophoraceae		
Chaetomprpha area (Dillw.) Kuetz. ..	Bombay.	
C. clavata (Ag.) Kuetz ..	Bombay.	
C. darwinii (Hooker) Kuetz ..	Malvan harbour (Dixit 1949) was earlier described as *C. media.* Later Dixit placed this species under *C. darwinii* and further stated that *C. clavata* recorded by Boergesen (1935) from Bombay is the same as this.	
C. indica Kuetz	Bombay (Boergesen. 1955).	
C. colabense Boergesen ..	Bombay.	
C crispata Kuetz .. .. Var. *acuta* P. Richt.	Deccan.	
Cladophora fascicularis (Martens) Kuetz. ..	Bombay.	
C. saracenica Boergs ..	Bombay.	
Lola capillaris (Kuetz) A. et. G. Hamel. ..	Bombay.	
Rhizoclonium grande Boergs ..	Bombay.	
R. kochinum Kuetz ..	Bombay.	
SIPHONALES		
Family Protosiphonaceae		
Bryopsis hypnoides Lamour ..	Okha Port.	
B. indica A. and E. S. Gepp.	Indian Ocean.	

TABLE No. II-4—*contd.*

Name (1)	Habitat (2)	Remark (3)
CAULERPACEAE		
Caulerpa fastigiata Mont. ..	Bombay.	
C. peltata Lamour	Bombay.	
C. racemosa (Forssk.) Weber V. Bosse. ..	Bombay.	
C. scalpelliformis (R. Hr.) Web. v. Bosse. ..	..	
F. dwarkensis Boergs ..	Bombay.	
Var. *intermedia* Web. v. Bosse.	Bombay.	
C. crassifolia (Ag.) J. Ag. ..	Bombay.	
Trichosolen mucronatum (Boergs.) Taylor. ..	Bombay.	
Family Dasycladaceae		
Acetabularia moebii Solms-Loubach.	Indian ocean Malvan.	
Family Codiaceae		
Codium indicum Dixit ..	Malvan harbour.	
C. latum Sur	Bombay.	
Halimeda papyracea Zan ..	Indian ocean.	
Family Valoniaceae		
Boodlea composita (Harv. et Hook. f.) Brand.	Dwarka, Okha.	
Chamaedores auriculata Boergesen. ..	Bombay, Dwarka, Indian Ocean.	
Cladophoropsis sundannensis Reinb.	Bombay, Dwarka.	
Struvea anastamosens (Harv) Piccone.	West coast of India.	
S. delicatula Kuetz	Bombay.	
Family Bryopsidaceae		
Pseudobryopsis mucronata (Boergs.)		
BACILLARIOPHYTA		
See under Bacillariophyta (p. 68).		

TABLE No. II-4—*contd.*

Name (1)	Habitat (2)	Remark (3)
PHAEOPHYTA		
DICTYOTALES		
Family Dictyotaceae		
Dictyota dumsoa Boergeson	Bombay.	
D. indica Sonder	Bombay.	
D. maxima Zanardini ..	Bombay.	
D. pinnatifida Kuetz ..	Bombay.	
Dilophus fasciola (Roth) Howe. ..	Bombay.	
Padina tetrastromatica Hauck	Bombay.	
Pocockiella variegata (Lamour) Popenfuss. ..	Dwarka.	
Spateglossum asperum J. Ag.	Bombay.	
S. variabile Fig. et.	Okha port.	
Stoechospermum marginatum (Ag) Kuetz.	Bombay.	
Zonaria variegata (Lamour) Ag.	Malvan, Dwarka.	
CHORDARIALES		
Family Myrionamataceas		
Ascocyclus orbicularis (J. Ag.) Magnus.	Dwarka.	
Hecatonama terminalis (Kuetz) Kylin. ..	Bombay, Dwarka.	
Myrionema strangulans Greville. ..	Porbandar.	
RHODOPHYTA		
BANGIOPHYCEAE		
FIORIDEOPHYCEAE		
NAMALIONALES		
Family Chantransiaceae		
Acrochastium sarqassicolum Boergs.	Bombay.	
ERYTHROPELTIDALES		
Family Erythropeltidaceae		
Erythrotrichia carnea (Dillw.) J. Ag.	Bombay.	

TABLE No. II-4—*contd.*

Name (1)	Habitat (2)	Remark (3)
Erythrotrichia carnea J. Ag.		All marine.
Acrochastium sarqassicolum Boergs.		
Gelidium pusillum (Stackh) Le Jolis.		
G. *pulvinatum* (Kuetz.) Thur. —forma *parvissima*.		
G. *heteroplastos Soergs.*		
G. *corneum* (Hude.) Lamour.		
G. *variabilis* (Grew.) Schmitz.		
Gelidiella myriocladio (Boergs.) Feldm. st. Hamel.		
Caulacanthus ustulatus (Mart.) Kuetz.		
Peyssonelia obscura Weg. var. *bombayansis* Boergs.	..	Do.
Cruoriella bicolor Boergs.		
Hildenbrandia prototypus Nardo.		
Amphiroa fragilissima (L.) Lamour.		
Chailosporum spectabiliie Harv.		
Jania rubens (L.) Lamour.		
Solieria robusta (Grev.) Kylin. var Waghlii.		
Grateloupia filicina (Wulf.) Ag.		
Sarconema filiciforma (Sond.) Kylin.		
Catenella repens (Lightf). Batt.		
Hypnea valentiae (Turn.) Mont.		
H. musciformis (Wulf.) Lamour.		
Gracilaria folifera (Forssk.) Boergs.		
G. corticata var *ramalinoides* J. Ag.	..	Do.
Gigartina acicularis (Wulf.) Lamour.		
Rhodymenia australia Sond.		
Monospora indica Boergs.		
Centracaras clavulatum (Ag.) Mont.	..	Do.
Spyridis alternans Boergs.		

TABLE No. II-4—*contd.*

Name (1)	Habitat (2)	Remark (3)
Myriogramme bombayensis Boergs.		
Caloglossa leprieurii (Mont.) J. Ag.		
C. bombayensis Boergs.		
Laurencia papillosa (Forssk) Grev.		
Chondria dasyphylla (Woodw.) Ag.		
C. cornuta Boergs.		
Acanthophora delilei Lam.		
Polysiphonia platycarpa Boergs. ..	..	All marine.
P. variegata (C. Ag.) Zan.		
Falkenbergia rufanulosa (Harv.) Schimitz.		
Batrachospermum moniliforme Roth. ..	..	Only fresh water form in Maharashtra
GELIDIALES		
Family Gelidiaceae		
Gelidium corneum (Huods.) Lamour.	Bombay.	
G. pulvinatum (Kuetz) Thurst	Bombay.	
G. pusillum (Stackh.) Lejolis.		
Family Gelidiellaceae		
Gelidiella bornetii (Web. v. Bosse). Feldmann et. Hamel.	Bombay.	
G. myrioclada (Boergs). Feldmann et. Hamel. ..	Bombay.	
CRYPTONEMLALES		
Family Squamariaceae		
Peyssonelia obscura Web. V. Bosse var. *bombayensis* Boergs.	Bombay.	
P. bicolor Boergs	Bombay.	
Family Hilderbrandtiaceae		
Hildenbrandtia prototypus Nardo. ..	Bombay.	

TABLE No. II-4—*contd.*

Name (1)	Habitat (2)	Remark (3)
Family Corallinaceae		
Jania rubeus (L.) Lamour.		
Family Grateloupiaceae		
Grateloupia filicipa (Wulf.) Ag.	Bombay.	
Family Gracilariaceae		
Gracilaria corticata J. Ag. ..	Bombay.	
G. foliifera (Forssk.) Boergs.	Bombay.	
Family Sphaerococeaceae		
Caulacanthus ustulatus (Mert) Kuetz.	Bombay.	
Family Solieriaceae		
Sarconema filiforme (Sond.) Kylin.	Bombay.	
Family Rhabdoniaceae		
Catenella repens (Lightf.) .. Batt.	Bombay.	
Family Hypneaceae		
Hypnea valentiae (Turn.) Mont.	Bombay.	
Family Gigartinaceae		
Gigartina acicularis (Wulfen) Lamour.	Bombay.	
RHODYMENIALES		
Family Rhodymeniaceae		
Rhogymenia australis Sonder	Bombay.	
CERAMIALE		
Family Ceramiaceae		
Centroceras clavulatum (Ag.) Mont.	Bombay, Dwarka.	
Corynospora indica Boerges	Bombay.	
Spyridia filamentosa (Wulf.) Harvey.	Bombay.	
Family Delessriaceae		
Acrosorium bombayensis Boergs.	Bombay.	
Acrosorium leprieurii (Mont.) J. Ag.	Bombay.	

TABLE No. II-4—*contd.*

Name (1)	Habitat (2)	Remark (3)
Family Rhodomelaceae		
Acanthophora delilai Lamour	Bombay, Okha Port.	
Chondria cornuta Boergs ..	Bombay.	
Taurencia palillosa (Forssk.) .. Greville.	Bombay.	
Polysiphonia platycarpa Boergs.	Bombay	
Polysiphonia variegata (Ag.) Zanardini.	Bombay, Okha port.	

Summary :

All Myxophyceae and the great majority of the Chlorophyceae, Bacillariaceae are fresh water algae. On the other hand, all Pheophyceae except *Ectocarpus* and the Rhodophyceae with the exception of *Batrachospermum* are marine algae. The list of Pheophyceae and Rhodopyceae are given separately in their proper places. Myxophyceae are fresh water forms. They are also given separately. Taken together tentatively they are as follows :—

(1) *Myxophyceae*.—Have no marine members. All are only fresh water.

Genera ..	..	..	95
Species ..	..	..	220

(2) *Chlorophyceae*.—These are both fresh water as well as marine forms.

A—Fresh water forms

Genera ..	..	..	150
Species ..	..	..	331

B—Marine forms

Genera ..	..	..	51
Species ..	..	..	83

(3) *Pheophyceae*.—All members are marine. The known genera are 15 and species about 20.

(4) *Rhodophyceae*.—Excepting the genus *Batrachospermum* which looks like a green alga and grows in fresh water, all others are marine. The number of marine Red algae is—

Genera ..	..	..	94
Species ..	..	..	120

4. *Fossil algae*.—The account of the fossil algae of Maharashtra occurring in different strata would be given elsewhere.

In all 385 Genera and 828 species of algae, excluding fossil algae, are so far known from Maharashtra. These numbers are bound to change as fresh work on algae at different places would come out. They would therefore, be considered only as tentative and not exhaustive.

The following Algae are common to Bombay and Ratnagiri-Sindhudurg coasts :—

CHLOROPHYTA :

1. *Enteromorpha flexuosa* (Wulf.) J. Ag.
2. *Chaetomorpha darwinii* (Hook.) Kuetz.
3. *Trichosolen mucronatum* (Boergs.) Taylor
4. *Chamaedoris auriculata* Boergs.

PHAEOPHYTA :

1. *Dictyota maxima* Zanardini
2. *D. pinnatifida* Kuetz.
3. *Stoechospermum marginatum* (Ag.) Kuetz.
4. *Nematocystus decipiens* (Sond.) Kuck.

RHODOPHYTA :

1. *Gelidiella acerosa* (Forssk) Feldmann et. Hamel.
2. *Coelarthrum muclleri* (Sons.) Boergs.
3. *Spyridia alternans* Boergs.
4. *Caloglossa leprieurii* (Mont.) J. Ag.
5. *Nitophyllum punctatum* (Staekh.) Greville.
6. *Laurentia pedicularicides* Boergs.

The following algae are found at Ratnagiri-Sindhudurg coastal areas but not at Bombay :—

CHLOROPHYTA :

Codium indicum Dixit

Acetabularia

PHAEOPHYTA

Zonaria variegata (Lamour.), Ag.

Sargassum cinereum J. Ag. var. *barberifolia* Gruenow

S. glaucescens J. Ag.

7. HABITATS OF ALGAE

Algae are highly susceptible to habitat changes, and the factors under which they grow. Different algal communities are formed depending upon the availability of food, range of temperature, oxygen content of water, pH, duration of light etc., particularly of Chlorophyceae, and diatoms. Like higher plants they are also affected by fungi and viruses. Mucilage secreted by the Cyanophyceae in fresh water attracts many organisms. They are *Laurania verigata*, *Helminthoaladia australis.* On rocks exposed to heavy brakers, species of *Chaetomorpha*, *Cladophora*, *Porphyra tenara*, *Gracillaria corticata* are found. In rocky puddles of different depth in the tidal zones species of *Enteromorpha*, *Chaetomorpha*

prostrata, *Acetabularia species*, *Caulerpa racemosa*, *Bryopsis pinnata*, species of *Padina* and *Gracilaria* occur. In very rocky pools *Caularpa-longifolia*, *Acitabularia* sp., *Codium dwarkensae* are found. In salt marshes *Enteromorpha compressa*, *E. prolifera*, *Rhizoclonium cochinianum* and *Cladophorella zoolingeri* are found. In oyster beds *Halymenia flexia*, *Gracilaria* and *Hypneum* species are found. On the walls of fresh water reservoirs *Cladophora* and *Enteromorpha* are common.

The distribution of algal species depends upon the factors of the habitat such as—

(a) Nature of substratum, (b) Pressure; (c) Temperature, (d) Duration of light, (e) Salinity and pH, (f) Shelter available, (g) Silt in tidal zone, (h) Exposure, etc.

Habitatwise classification of Algae is given by Tiffani (1951) in *Manual of Phycology*, pp. 293-311 as follows:—

I.	*Hydrophytes* ..	Algae more or less completely submerged or floating.
	2. *Benthophytes* ..	Algae growing on mud at the bottom of water and subtratum.
	3. *Epactiphytes* ..	Algae growing along banks of lakes and ponds.
	4. *Thermophytes* ..	Algae of thermal springs and in hot water as at Vajreshwari.
	5. *Planktophytes* ..	Algae that floats on water.
	6. (*a*) *Euplanktophytes*	True floating algae.
	(*b*) *Tychlophytes* ..	Flaoting mats of algae, due to accident of wind or other agencies.
	(*c*) *Halophytes* ..	Algae of waters with high salt concentration.
	7. *Epiphytes*	Algae growing on other plants.
	8. *Epizoophytes* ..	Algae growing on animals.
II.	*Endophytes* ..	Algae growing within other plants.
III.	*Saprophytes* ..	Humus rich surface algae.
IV.	*Cryptophytes* ..	Subterranean algae.
V.	*Acrophytes*	Algae floating on sheets of snow.

8. Habits of Algae

Algae are extremely choosy in their habitat. Many of them grow in marine waters, some on coast, some in estuaries, some on moist soil and rock surfaces, wet walls, some in fresh water lakes, in flowing river streams,

places where water is dripping, in isolated ponds and puddles, permanent sheets of water or temporary monsoon ponds etc. Some grow in soil. A few grow epiphytically on tree bark. A very few grow on leaves. Some grow symbiotically. They generally indicate fresh or stagnant condition of water, depending upon the species growing therein. Some grow on pebbles in flowing river or at the bottom of ponds. Some float on surface of large sheets of water in lakes and sea.

Feldmann (1937) has classified the Biological or Life Forms of algae as follows :—

I. *Annuals* :

(*a*) *Ephemerophyta.*—Forms that are found all the year round forming several generations without any resting period e.g. *Cladophora, Enteromorpha, Polysiphonia.*

(*b*) *Edipsiophyta.*—Plants that are reduced to microscopic forms during their life cycle in one part of the year or the other, and become megascopic again during the other part e.g. *Nereia, Sporochnus.*

(*c*) *Hypnophyta.*—Algae that form resting stages or cysts during the year e. g. *Ulothrix, Oedogonium Spirogyra, Chara, Vaucheria, Porphyra.*

II. *Perennials :*

(*a*) *Phanerophyta.*—These have perennial growth habit e.g. *Codium Chara, Fucus etc.*

(*b*) *Chamaephyta.*—Here the whole plant body is perennial growing horizontally as encrustment e.g. *Lithophyllum, Hilderbrandtia.*

(*c*) *Hemicryptophyta.*—Plants in which only the basal part persists throughout the year and forms new plants by means of creeping filaments e. g. *Acetabularia, Cladostephus.*

Many algae form distinct plant communities growing on the bottom mud of a body of water. Some grow in hot water springs at a temperature 40°-87°-C e.g. *Oscillatoria, Trevis, Nostoc* and *Haplosiphon* species., some grow even below snow.

In tropical seas algae form huge masses of plankton in which several Flagellates, Cyanophyceae, Desmids, members of Chlorococcales grow together with many animals. Some grow in salt marshes and have marine species. These are really the halophytes e.g. *Prasiola, Enteromorpha, Cladophora, Pithophora, Ulva, Padina etc.*

Epizoophytes :

Some algae grow on other organisms, such as snails, mosquito larvae, turtle, fish, sponges etc. e.g. *Characium, Chlorella* etc. Epiphyllous algae growing on tree bark e. g. *Nostoc*, members of Chroococales etc., *Cephaleura* grows on Tea leaves.

Soil Algae :

The soil algae generally grow at the surface of soil or in the soil upto about a metre depth below the soil level. Surface dwellers are *Oscillatoria, Linghya, Phormidium, Navicula, Nostoc* etc. Those that grow deep in the soil are *Cephaleura, Polysiphonia. Plerococcus* species.

Algae on calcarious soil. :

They are calcicoles and prefer to grow on calcarious soil e.g. *Phormidium, Prasiola, Trentepohlia, Stigonema.*

Symbiotic Algae :

It is well known that *Nostoc* grows within the roots of *Cycads* and *Anabaena* in the leaf folds of *Azolla* symbiotically. *Fritschiella, Botrydium* and *Chlorella* grow on the edge of ponds where a lot of animal excreta are dropped. They are supposed to be good oxidants. Some algae like *Volvox* grow isolated in walls or in temporary mountain pools. Here they perennate by the formation of cysts.

Rocky pools of fresh water :

These contain *Ulothrix, Cladophora, Tolypothrix, Spirogyra Coleochaete, Oedogonium, Zygnema* species.

Algae in rain water pools :

Rain water pools which dry up later often contain *Euglena, Rhizoclonium, Microspora, Ulothrix.* They are dominant in summer.

Algae of Brackish water :

Cladophora, Pithophora, Bryopsis etc. have species which are halophytes. *Calothrix, Euglena, Vaucheria* grow on moist soil rich in humus and supplied with brackish water.

Microspora, Ulothrix. Bulbochaeta are found as epiphytes on aquatic plants. Chlorella occurs in the cells of Hydra. It fills tank completely.

Marine Algae :

In tropical deep waters mass of plankton forms a spectacular sight. In shallow waters towards the coast diatoms occur in profusion. In temperate countries algae generally show zonation, e. g. belts of one plant community growing by the strip of another plant community, especially if the shore is rocky, along alkaline cliffs e. g. at Dover, Cardiff in England. Such a phenomenon, however, is not very marked in India except on the Saurashtra coast at Veraval, Okha, and at Khodiar, Cape Camorin etc.

It will be seen from the above how rich we are in both fresh water and marine algae. Their utilization is dealt with in next section 10 although, it has to be admitted that not much has been done for industrial purposes. In these days of industrialization, green algae will become more and more important as fertilizers and as agents in oxygenation ponds.

9. Ecological Succession Periodicity and Distribution of Algae in Fresh Water Lakes in Maharashtra. Rankala Lake (Kolhapur) as an Illustration.

Studies on algae of the old Bombay Presidency really began with the work of A. J. Cerlers (1858) who made a study of some members of Volvocaceae, Flagellates in puddles in Bombay. In 1863 Hobson described two new species of *Dosodium pistidas* Hobs collected at Mahabaleshwar. A few members of the other fresh algae belonging to Myxophyceae, Chlorophyceae, Distemaceae and Desmidaceae were also mentioned by workers like Nellie Carter in her paper on fresh water algae from India.

After initial period, a number of botanists of different countries took interest in studies on algae in India. Eventually the Rev. Father Ethelbert Blatter S. g. of St. Xavier College, Bombay made several collections of algae. Later S. C. Dixit and Mrs. E. Gonzalves and her students N. D. Kamat, Mrs. Ganla, Vaidya made several contributions to the studies on algae. A large number of algae of different groups at Dharwar, Bombay, Ahmedabad, Nagpur, Aurangabad were studied and described by Dixit, Gonsalves, Ganla, H. P. Gandhi, N. D. Kamat, R. G. Patil, M. S. Balakrishnan and others.

Most of these studies dealt with taxonomy of algae and a few with cytology and life cycles. Balkrishnan was the only one to study cytology, ecology and distribution at a few places in Maharashtra where a number of ecological nitches encourage rich aquatic vegetation including algae. The basic rock in most places was trap or basalt. It provided water and debris subsequently gathered in pools and gave rise to particular algal flora. The only detailed account of such plant communities is by Kamat (1965) who studied fresh water lakes and puddles around Kolhapur 16° 42' and 7.8° 14' E, altitude 570' above the mean sea level. pH of water in many places is slightly alkaline varying from 7-6 to 8-5.

Periodicity of algae in Temporary Ponds and Lakes :

Many of the ponds in Kolhapur are rain water ponds or puddles, but some lakes have permanent water. Rain water puddles generally dry up after October, and with the onset of first rains *Volvox*, *Clamydomonas*, *Gloecystis*, *Tetraspora*, *Ulothrix* begin to appear. *Cylindrocapsa geminella* appears in September, *Protococcus viridus*, *Stigeoclonium lubricum* become quite common by June. *Cladophora perciformis* and *C. elegans* generally inhabit permanent waters till May. *Coleochaete* scutata, *C. irreqularis* and *C. orbicularis* appear in September-October and last till January. By far the common members of Chlorophyceae that appear in temporary and permanent ponds are species of *Oedogonum purrituen*, *O. regulosum*. They come to fruiting in January and remain till the end of May. *O. longipilum*, *O. lanturense* and *O. pusillum* produce generation after generation till May, while *O. E. pseudispirale*, *Oetapeius sporum* produce the first generation in September, and second in January. One species of *Bulbochaete brerfulla* appears in August and produces fruitifications till January. *Oedocladium* species appear on moist soil in July and last till the end of rainy season.

Enteromorpha proflifera grows from January to May. As the temperature of water rises *Pithophora oedogerua* is found from July to May. *Cladophora callicoma* grows attached to rocks in clear water and on snails till May. From October *Rhizoclonium hieroglyphicum* appears on the moist soil after rains. *Cosmarium*, *Closterium* species occur commonly

from August to October. *Euastrum* and several desmids appear from August to March, *Desmidium* which is rare, occurs in February, *Spirogyra* occurs dominating throughout the year, next only to *Oedogonium*. The species such as *Spirogyra spreeiana*, *S. submaxima*, *Zygnama monoiense* appear side by side with *Spirogyra*. *Oedocladium*, appears on moist soil. *Hydrodictyon reticulature*, *Scenedesmus*, *Pediastrum* sps. appears from September to May. *Chara* and *Nitella* begin to appear by mid-July and continues fruiting till they die. They are annuals.

Among Cyanophyceae *Aphancapsa*, *Gloeotheca*, *Microcystis Microchaete uberima* form two generations, the first in September-October and the second in March-May. *Fortiea bossei var indica* was found on the dripping rocks only. *Aulosira fruitilissima* var *tenuis* appeared as slimy floating masses in August. *A. implexa* var *crama* and *A. fertilissima var tenuis* are found in August-September in various aquatic habitats.

Calothrix, *Gloeotriaechia* and *Chaetomorpha* appear in September--October ; species of *Scytonema*, *Petalonema* and *Tolypothrix* appear from June to October. All species of *Anaebaena* form generations after generations. *Nostoc*, *Spirulina*, *Oscillatoria* are the first algae to appear during rainy season, followed by *Phormidium*, *Lyngbya*. *Diatoms* are particularly abundant from October to March. *Euglena* and *Trachelonema* are found throughout the year.

In dried ponds *Euglena* species, diatoms and *Clamydomonas*, *Spirogyra* appear soon after the monsoons.

It will be seen from above that most dominant algae in lakes are *Spirogyra* and *Oedogonium* in March. According to Fritsch (1907) species of *Oedogonium* are quite dominant in tropical pond waters, whereas *Cladophora* and *Rhizoclonium* are rather rare. *Vaucheria* is quite rare, as it requires colder climate. Curiously enough it is abundant at high altitude at Saptashrungi in Nasik and also at Mount Abu. Only one species of *Bulbochaecte* is found, but rather rare. It grows in clear and flowing water in places where abundant desmids grow.

In Maharashtra there are no large lakes, Rankala (Kolhapur), Venna lake at Mahabaleshwar, Vihar and Tulsi lakes near Bombay and the lake near Buldhana are rather small. But whatever they are, the ecology and succession of algae in them needs to be studied. The growth of important algae in Rankala and other ponds in Kolhapur is given in Table No. II-5.

Since there is no complete list of algae to facilitate the collection and study of their developmental stages, life cycles, the lists of algae of different places from where they are known are given here(See pp.100-116). There is a gap in our knowledge of the algae in Vidarbha lakes and ponds as also algae from fresh water tanks at Nagpur, Khandesh, Aurangabad and other localities in Marathwada, places on Konkan coast. Maharashtra seems very rich in algae both fresh water as well as marine and also that grow in cool ponds and lakes on hill tops.

9·1. Growth of Important Algae in Rankala and Other Ponds at Kolhapur

TABLE No. II-5

Growth of Important Algae in Rankala and Other Ponds at Kolhapur (After N. D. Kamat. 1965)

CHLOROPHYCEAE			CYANOPHYCEAE		
Name of species (1)	Month of occurrence (2)	Fruiting occurrence (3)	Name of species (4)	Month of occurrence (5)	Fruiting occurrence (6)
1 *Volvox sp.*	September-October vegetative. ..	..	14 *Microcystis* .. .. 15 *Microchaete uberima.*	September to October..	1st generation September-October. 2nd generation March-May.
2 *Gloeocystis* sp.	January-April	..			
3 *Tetraspora* sp.	August-September ..	..	16 *Fortiea bossei* var *indica*.	.. ..	September-October.
4 *Ulothrix* sp.	July-January	..			
5 *Cylindrocapsa*	Beginning September ..	End of September to 1st fortnight of October.	17 *Aulosira fertilissina* V. *tenuis*.	August	September-October.
6 *Oadogonium* sp. ..	..	July-May-January ..	18 *Calothrix*	Throughout the year ..	September-October.
7 *Oedocladium* sp. ..	July	..			
8 *Cosmarium* sp.	July-May	..	19 *Gloeotrichia*	August	September-October.
9 *Spirogyra* sp.	All the year round ..	August-May .. .. September-October.			
10 *Zygnema* sp.:	All the year round ..	August-September ..	20 *Cylindrospermum* sp.	..	August-October.
11 *Mougeotia* sp.	July onward	September	21 *Nostoc* sp. .. .. 22 *Spirulina* sp.	Throughout the year.	
12 *Sirocladium kumaoense*..	Beginning of August ..	Late September			
13 *Nitella* sp.	Mid July	August			

10. ALGAE FOR FOOD, MANURE AND INDUSTRIAL USES.

Search for new raw materials for food industry is a continuous process in advanced countries. Marine resources of India are being systematically surveyed and tackled only recently since the establishment of the Central Salt and Marine Chemicals Research Institute at Bhavnagar, Central Oceanographic Institute at Goa, and Central National Institute of Fisheries at Cochin. This has been deemed as a step in the right direction ; but so far as the plant resources are concerned no significant organised attempts at collection and industrial utilization of algae have been made. Sporadic attempts are made at several places like Okha, Veraval, Vengurla, Malvan, Kottayam, Kanyakumari, Talai Manyar and Cochin, where collections are made by individuals and exported. The main difficulty however, seems to be of not getting any large quantity of drift in bulk necessary for industrial purposes and a guaranteed supply of raw material of algae for extraction. In Maharashtra large quantity of drift is not available as at Kanyakumari or Veraval, nor any systematic attempts for the cultivation of marine algae in rocky pool behind the tidal zones are made. This is possible at certain places like Danda beach at Bombay, Alibag, Malvan, Ratnagiri where seashore is rocky upto Karwar and Goa. But there has been no development in this direction either by the local people or the government. It is known that sea near Malvan, Vengurla is rich in food for animals and plant growth of marine algae.

Attention to this source of raw material for industrial purpose was drawn by Col. Hornell at the suggestion of the late Sayajirao Maharaj of Baroda in his admirably good report on the marine resources of Okha Mandal. After that the only regular work on this important problem is being done on Saurashtra coast by the members of staff of Central Salt and Marine Chemicals Research Institute at Bhavanagar (1970). It is high time that along with the reclamation of Khar lands on the Western coast, attempt be made to explore the possibility of utilization of naturally occurring economic algae e. g. *Gracilaria, Hypnea, Sargassum* as the raw material for certain industries like iodine, Agar Agar, algin, alginic acid and their derivatives.

Algae constitute the most important food of marine organisms, and also of man. Species of *Ulva, Porphyra, Nostoc* are used as food since long in China, Japan, parts of India, Scotland etc. They contain good many minerals and vitamins. For example, *Microcystis* is rich in Vitamin A and Vitamin C. Certain Brown Algae are still richer in them as they contain 17 per cent of aminoacids, 11.6 per cent fat, 54 per cent carbohydrates in various forms of sugar like mannitol 5.37 per cent, Laminarin protein 36 per cent, cellulose 1.9 per cent, algin 50 per cent, all digestible. A look at the analysis of *Gracilaria* shows how rich it is in Vitamin-B, Carotene, Thiamine and Sulfaflavin, Pyrenoids. It contains 15 per cent lipids, 30 per cent proteins, 30 per cent carbohydrates, 5 per cent minerals. It is believed that it is a good source of food for man and cattle. *Chlorella* ice-cream is served in Japan and in Chinese restaurants. It is well known that planktonic masses are the chief food of marine animals in tropical and sub-tropical sea waters. Similarly in fresh water lakes *Oedogonium, Spirogyra, Cladophora, Pithophora, Enteromorpha, Microspora* form the food of fishes. In marine plankton *Amansia glomerata, Ectocarpus, Hydrocoleus* are important food of sea animals. The mineral contents of most of the marine algae are high, but some of them are particularly rich in iodine e. g. *Laminaria*. According to Van Fallenberg (1926) some aquatic species of *Vaucheria* also contain iodine. Some algae also serve as good cattle feed.

10.1. Algae as a raw material for Industries.

The main products obtained from algae are agar agar from species of Red Algae *Hypnea, Gelidium, Gracilaria, Chondrus etc.* It is used in medicinal preparations, biological cultures, in cosmetics, in leather and textile industries, for establishing emulsions and suspended solids etc. Some of them like *Chondrus crispus* also yield complex polysaccharids, but they are mainly exploited for alginic acid and alginates. They are added to ice-cream, cosmetics, printing ink and to rubber tyres. In emulsified form they are used in polish, ice-cream, cheese, jellyes etc.

The fossil diatoms preserved in Palaeozoic deposits as kieselghur are used in dynamite. The palaeozoic oil deposits are rich in a diatom called *Nitzschia.* Algae also are a good source of fertilizers.

Chlorogloia, Fritschiella, Cylindrospermum, Nostoc commune, Anabaena cylindrica, Ulothrix brevissima, Tolypothrix tenuis, Mastigocladus laminosus and *Aulosira fertilissima* fix atmospheric nitrogen and enrich the wet soil in rice fields.

Certain antibiotics have been reported from *Laminaria digitata Polysiphonia species. Chlorella* contains an antibiotic called Chlorellin, It inhibits growth of bacteria. Some of them also produce auxins e. g. *Microcystis aeruginosa. Ulva lactuca* produces IAA type of auxin.

But the main concern of man, especially in large towns, is the question of pollution of water or air, it looms large. Algae like *Oscillatoria, Chlorina, Euglena, Spirulina* indicate polluted water devoid of oxygen. *Chara* indicates clear water. Several algae are grown for oxyenation ponds in industrial areas.

Some algae are good soil binding agents. They are good surface binders especially *Nostoc commune, Scytonema* and *Anabaena* species. They help to improve the crop soil. It is said that Blue green Algae of rice fields increase nitrogen by nearly 2 per cent.

10.2. Algae and Iodine Industry.

Different Brown and Red algae are known to contain different amounts of Iodine. Generally Brown Algae are better than Red algae—which are better than Green Algae—for this purpose. But of all these, the highest source of iodine are the species of *Laminaria.* They are thrown out on shore during high tide near the high tide mark. Iodine content of marine algae of Gujarat coast is given in Table No. II-6.

TABLE No. II-6

Iodine Content of Marine Algae of Gujarat Coast.

(After Kappana, A. N., Sitakara V. Rao 1962).

Algae (1)	Moisture in the air dried algae % (2)	Iodine/100g. air dried algae mg. (3)
PHAEOPHYCEAE		
Colpomenia sinuosa (Roth) Derb. et. Sol.	7.034	8.356
A member of the Custoseiraccae.	16.900	28.400
Myriogloea sciunus (Harv.) Kuck.	10.010	104.500

TABLE No. II-6—*contd.*

Algae (1)	Moisture in the air dried algae % (2)	Iodine/100g air dried algae mg· (3)
Sargassum cinereum J. Ag. Var. *berberifolium* Grun. ..	12.200	20.610
Sargassum johnstonii Setch a Gard	16.840	24.460
Spathoglossum variabile Fig. et. De. Not	10.590	16.440
RHODOPHYCEAE		
Acanthophora delilei Lamx.	11.620	5.782
Agardhiella tenera (J. Ag.) Schmits	11.090	12.650
Gracilaria folifera (Forssk) Boergs.	10.390	15.750
Heterosiphonia muelleri (Sond) De Toni	10.570	10.010
Polysiphonia ferulacea Suhr.	5.242	39.060
Polysiphonia sp.	7.553	4.781
Sarocunema furcellatum Zenard	6.366	8.634
Scinaia indica Boergs.	11.510	5.621
Solieria robusta (Grev.) Kylin	5.744	15.540
CHLOROPHYCEAE		
Cladophora manumentalis Boergesen	8.360	59.240
Codium dwarkense Boergesen	4.964	5.051
Ulva lactuca Linnaeus	6.125	1.986
Ulva rigida (C. A. Agardh.) Le Joli	15.200	4.094

10.3. SEA-WATER AND ITS CONTENTS.

According to *Encyclopedia of Science and Technology,* Vol. 12, p. 108 analysis of sea-water has the following main constituents.

$H^{2}O$	..	..	96.5
Na	..	..	1.05
Kg	..	..	0.04
Mg	..	..	0.13
Ca	..	..	0.04
Cl	..	..	1.9
S	..	..	0.09

The sea-water on an average contains up to 2 mg of Iodine per litre mainly in organic form. The species of *Laminaria* of all sea weeds contains the largest amount ; but the data, regarding actual percentages in dry weight is variable ; for example, according to Kylin stipes of *Laminaria saccharina* contains 0;19 Potassium iodine in the fresh weight, but

in *Laminaria gloustoni* stipes contains 0.30 per cent. In the members of Fucales it is only 0.02 per cent etc. Iodine is located in special cells (Fritsch, 1945, 2 : 34-35).

Sea-water contains several major and minor and trace elements and organic substances. They are extracted from it by processing. Common salt (NaCl) is an outstanding example. Analysis of sea-water which contains several major, minor and trace elements are given on page 96. On an average it contains 3-3.5 per cent of salt all taken together. Its salinity and chlorinity are inter-related.

Sea weeds like *Ulva* contain ascorbic acid. Growth hormones are formed by it. Sea farming is not common in India as in Japan, for food from sea weeds, for pearl fisheries, for preparing manure etc. Other products such as Agar-agar, alginic acid are obtained from sea weeds. Of various products from sea weeds next to Iodine Agar-agar from Red Algae and alginic acid from Brown algae are more important.

They also are rich in proteins and as such are good supplementary feed for cattle.

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Algae of Different Places and Regions are Given Next In No. 11—19

11. ALGAE OF BOMBAY

EUGLENOPHYTA

Family Euglenaceae

1. Genus *Euglena*
   - (1) *Euglena acus* Ehren
   - (2) *E. charkowiensis Swir*
   - (4) *E. fusca* (Klebs) Lemmermann
   - (4) *E. gibbosa Schiller*
   - (5) *E. pusilla Palyfair* v. *longa Playfair*
2. *Lepoeinclis ovum* (Ehren.) Lemm.
3. Genus *Phacus*
   - (1) *Phacus caudatus* Hubner
   - (2) *P. caunvicauad* Swirenke
   - (3) *P. hameli* Allorge et Lefevre
   - (4) *P. helikoides* Pochm
   - (5) *P. longicauda* (E) Dujardin
   - (6) *P. maharashtrensis* Kamat
   - (7) *P. orbicularis* Hubner
   - (8) *P. pekinenis* Skvorts
   - (9) *P. pleuromectus* (O. F. M.) Dujardin
   - (10) *P. tortus* (Lemm.) Skv.
   - (11) *P. triqueter* (E) Dujardin
4. Genus *Trachelomonas*
   - (1) *T. abrupta* Swir emend Deflandre v. *minor* Deflandre
   - (2) *T. armata* (E.) Stein
   - (3) *T. armata* (E.) Stein V. *steinii* Lemm. emend. Deflandre
   - (4) *T. dybowskii* Drez.
   - (5) *T. hexangulata* (Swir.) Playfair
   - (6) *T. hispida* (Perty) Stein emend. Deflandre
   - (7) *T. oblonga* Lemm. v. *Major* Kamat
   - (8) *T. volvocina* Ehrenberg
   - (9) *T. volvocina* Ehrenberg V. *derephora* Gonrad
   - (10) *T. vol ii* Lemm. V. *cylindrica* Playfair
   - (11) *T. woycickii* Koczware v. *bombayensis* Kamat

CHLOROPHYTA

Family Ulvaceae

5. Genus *Ulva*
   - (1) *U. lactuca* (L.) Le Jolis
   - (2) *U. reticulata* Forssk
6. Genus *Enteromerpha*
   - (1) *E. flexuosa* (Wulf.) J. Ag.
   - (2) *E. tubulosa* Kuetz.
   - (3) *E. prolifera* (Fl. Dan.) J. Ag.
7. Genus *Entocladia*
   - (1) *E. immanes* elimidle
   - (2) *E. leptochaete haber*

Family Valoniaceae

8. Genus *Valonia*
   - (1) *V. aegagraphila* C. Ag.
   - (2) *V. utricularis* (Both.) Ag.

Family Cladophoraceae

9. Genus *Rhizoclonium*
   - (1) *R. kochianum* Kuetz.
   - (2) *R. grande* Boergs
10. Genus *Chaetomarpha*
    - (1) *C. indica* (Muell.) Kuetz.
    - (2) *C. area* (Dillw.) Kuetz.
    - (3) *C. antennina* (Eory) Kuetz.
    - (4) *C. clavata* (Ag.) Kuetz.
11. Genus *Lola*
    - (1) *L. capillaris* (Kuetz.) A. et. G. Hamel
12. Genus *Cladophora*
    - (1) *C. saracenica* Boergs
    - (2) *C. colobense* Boergs
    - (3) *C. bomboyensis* Boergs
    - (4) *C. monumentalis* Boergs
    - (5) *C. crispata* Boergs
    - (6) *C. fascicularis* Mertens

Family Palmellaceae

13. Genus *Gloeocystis*
    - (1) *G. aempla* (Kuetz.) Langerheim.
    - (2) *G. gigas* (Kuetz.) Langerheim.

Family Protococcaceae

14. Genus *Protococcus*
P. vindus Agardh

Family Siphonocladiaceae

15. Genus *Strukea*
(1) *S. delicatula* Kuetz.

Family Bryopsidaceae

16. *Pseudobryopsis mucronata*

PHAEOPHYTA

Family Ectocarpaceae

17. Genus *Ectocarous* Kuetz.
(1) *E. irregularis* Kuetz.

Family Sphacelariaceae

18. Genus *Sphacelaria*
(1) *S. furcigera* Kuetz.

Family Dictyotaceae

19. Genus *Dictyopteris*
(1) *D. acrostichoides* I. Ag.
(2) *D. bartayresiana* Lamour.
(3) *D. dumosa* Boerg.
(4) *D. maxima* Zan.
(5) *D. atomaria* Hauck.
(6) *D. pinnatifida* Kuetz.

20. Genus *Diloplus*
(1) *D. fascida* (Roth) Howe.

21. Genus *Spathoglossum*
(1) *S. asperum* J. Ag.

22. Genus *Stoechospermum*
S. marginatum (Ag.) Kuetz

23. Genus *Padina*
(1) *P. tetrastromatica* Hauck.

Family Chordariaceae

24. Genus *Myriactula*
(1) *Myriactula arabica* (Kuetz) Feldm.

Family Spermatochnaceae

25. Genus *Nemacystus*
(1) *N. decipiens* (Sur.) Kuck.

Family Punctariaceae

26. Genus *Rosenvingea*
(1) R. *intricata* (J. Ag.) Boergs.

27. Genus *Colpomenia*
(1) *C. sinuosa* (Roth.) Derb. et. Sol.

Family Sargassaceae

28. Genus *Cystophyllum*
    (1) *Cystophyllum muricatum* (Turn.) J. Ag.
29. Genus *Sargassum*
    (1) *S. cinereum* J. Ag. var. *berberifolia* Grun.
    (2) *S. ilicifolium* (Turn.) C. Ag. var. *vanusta* Grun.

RHODOPHYTA

Family Bangiaceae

30. Genus *Erythrotrichis*
    (1) *E. camea* J. Ag.
31. *Goniotrichum*
    (1) *G. elegans* (Chauv.) Le Jolis

Family Chantransiaccae

32. Genus *Acrochaetium*
    (1) *A. sargassicolum* Boergs.
33. Genus *Liagora*
    (1) *L. ceranoides* Lamx.
34. Genus *Scinia*
    (1) *S. hatei* Boergs.
    (2) *S. indica* Boergs.

Family Gelidiaceae

35. Genus *Gelidium*
    (1) *G. pusillum* (Stackh.) Le Jolis
    (2) *G. pulvinatum* (Kuetz.) Thur. forma *parivssima*
    (3) *G. heteroplastos* Boergs.
    (4) *G. corneum* (Huds.) Lamour.
36. Genus *Gelidiopsis*
    (1) *G. variabilis* (Grev.) Schmitz.
    (2) *G. myriocladia* Boergs. Feldm. et Hamel.
37. Genus *Gelidiella*
    (1) *G. acerosum* (Forssk.) Feldm. et Hamel.
38. Genus *Caulacanthus*
    (1) *C. ustulatus* (Mert.) Kuetz.

Family Squamariaceae

39. Genus *Peyssonnelia*
    P. obscura Web.
    P. bosse var. *bombayensis* Boergs.
40. Genus *Cruoriella*
    C. bicolor Boergs.
41. Genus *Hildenbrandia*
    H. prototypus Nardo.

Family Corallina

42. Genus *Amphiroa*
    A. frogilissima (L) Lamour.
43. Genus *Cheilosporum*
    C. spectabile Harv.
44. Genus *Jania*
    J. rubens (L.) Lamour.

Family Solieriaceae

45. Genus *Solieria*
    (1) *S. robusta* (Grev.) Kuln, var. *waghtii.*
46. Genus *Sarconema*
    S. furcatum Boergs.
47. Genus *Agardhiella*
    A. robusta (Grev.) Boergs.

Family Rhabdoniaceae

48. Genus *Catenella*
    C. repens (Light.) Batt.

Family Hypneaceae

49. Genus *Hypnea*
    (1) *H. velenliae* (Turn.) Mont.

Family Sphaerococcaceae

50. Genus *Chrysymenia*
    (1) *C. uvaria* (L.) Jag. forma.
    luxuriana Boergs.

Family Gracilariaceae

51. Genus *Gracilaria*
    (1) G. *folifera* (Forssk.) Boergs.
    (2) G. *corticata* var. *ramalinoides* J. Ag.

Family Gigartinaceae

52. Genus *Gigartina*
    (1) *G. acicularis* (Wulf.) Lamour.

Family Rhodymeniaceae

53. Genus *Botryocladia*
    (1) *B. leptopoda* (J. Ag.) Kylin.

Family Champiaceae

54. Genus *Champia*
    (1) *C. somalensis* Hauck.
    (2) *C. indica* Boergs.
55. Genus *Rhodymenia*
    Rhodymenia australis Sond.

Family Geramiaceae

56. Genus *Monospora*

(1) *M. indica* Boergs.

57. Genus *Ceotrocespas*

C. filamentosa (Wulf.) Harv.

58. Genus *Spyridia*

S. filamentosa (Wulf.) Harv.

59. Genus *Griffithsia*

(1) *G. duperreyi Mont.*

(2) *G. flabelliformis* Harv.

60. Genus—*Cautroceras*

(1) C. clavaulatum (Ag.) Mont.

Family Delesseriaceae

61. Genus *Myriogramme*

(1) *M. bombayensis* Boergs

62. Genus *Caloglossa*

(1) *C. leprienrii* (Mont.)

(2) *C. bombayensis* Boergs.

Family Rhodomelaceae

63. Genus *Laurencia*

(1) *L. papillosa* (Forssk.) Grev.

(2) *L. obtusa* (Huds.) Lam.
var. *diverticata* Harv.

(3) *L. majuscula* Harv.

(4) *L. pedicularioides* Boergs.

64. Genus *Chondria*

(1) *C. dasypylla* (Woodw.) Ag.

(2) *C. cornuta* Boergs.

65. Genus *Acanthophora*

A. dendroides Harv.

66. Genus *Polysiphonia*

(1) *P. platycarpa* Boergs.

(2) *P. variegata* (C. Ag.) Zan.

(3) *P. Ferulaceae* Suhr.

67. Genus *Roschera*

R. glomerulata (C. Ag.) Web.
V. Bosse.

68. Genus *Leveillea*

L. jungermannioides (Mart. et. Her.) Harv.

Family Dasyaceae

69. Genus *Heterosiphonia*

(1) *H. muelleri* (Sond.) De Toni

(2) *H. wurdemann.* (Baill).
Falkb. var *laxa* Boergs.

70. Genus *Falkenbergia*

(1) *F. rufanulosa* (Harv.) Schmitz.

12. Algae of Alibag

(After N. D. Kamat, 1968, *J. B. N. S.* **65** : 88-104)

CYANOPHYTA

Family Chroococcaceae

Name	Habitat and Locality
1. Genus *Microcystis*	
(1) *M. aeruginosa* Kuetz ..	Common in puddles, ponds.
(2) *M. flos*-aquae (Wittr.) Kirchn.	In pools, ponds, Alibag, Poynad
2. Genus *Merismopedi*	
(1) *M. glauca* (Ehr.) Naeg. ..	In brackish water ponds, Koproli
(2) *M. tenuissima* Lemm	In ponds.
(3) *M. punctata* Mayen ..	In ponds, Koproli
3. Genus *Chroococcus* :	
(1) *C. tenax* (Kirch.)—Hieron.	In paddy fields, Saral, Zirad,
(2) *C. turgidus* (Kuetz.)—Nag.	Rare.—In paddy fields, Saral

Family Oscillatoriaceae

Name	Habitat and Locality
4. Genus *Oscillatoria*	
(1) *O. amphiba* Agardh ..	In a rackish water outlet, Rewas
(2) *O. annae* van Goor ..	In Khar paddy fields, Poynad.
(3) *O. brevis* (Kuetz.)Gom.	In brackish water outlet, Rewas.
(4) *O. chalybsa*(Mar.)Gom.	In a gutter, Saral; with Calyptera.
(5) *O. claricentrosa* Gard	In paddy fields, Saral.
(6) *O. formosa* Berry ..	In paddy fields, Zirad, on the dam wall Tinviza.
(7) *O. limosa* Agardh ..	In brackish water outlet, Rewas
(8) *O. mougeiotii* Kuetz ..	Planktonic in a Bodhan,* Koproli.
(9) *O. pseudogenubata* G. Schmid.	In Khar paddy fields, Rewas.
(10) *O. pseudogeminata* G. Schmid v. *unigranulata* Biswas.	Planktonic in a Bodhan* Koproli.
(11) *O. pseudogeminata* G. Schmid v. *unigranulata* Biswas.	In Khar paddy field, Rewas. In the mucilageneous masses of *Gloeotrichia* in a paddy field, Thal.

*Bodhan means stone bund.

Name	Habitat and Locality
(12) *O. rebescens* D. C. ex Gom. f. *ahmedubadensis* Kamat.	On moist soil near a gutter, Saral.
(13) *O. schultzii* Lemm. v. *cyclinadrica* Kamat.	In a gutter, Saral.
5. Genus *Lyngbya*	
(1) *L. aerugineo-coerulea* (Kuetz.) Gom.	In the mucilagenous masses of *Aphanotheca* sp. in a paddy fields.
(2) *L. majuscula* Harvey ex Gom.	In a pond, Saral.
(3) *L. palmarum* (Mart) Bruehl et Biswas.	On stones in a fast running streamlet, Saral.
(4) *L. perelegans* Lemm ..	In Khar paddy field, Rewas,
(5) *L. polysiphona* Fremy ..	In a streamlet, Saral.
(6) *L. semilplena* (Agardh) J. Ag. ex. Gom.	In a puddle, paddy fields, Koproli. Saral.
(7) *L. shacklton* W. et. G. S. West.	In a Bodhan, Satghar.
6. Genus *Symploca*	
(1) *S. muscorum* (Agardh) Gom.	On moist soil near a wall, Saral.
7. Genus *Polychlamydum*	
(1) *P. insigne* W. et. G. S. West.	Planktonic in Khar paddy fields, Rewas, Shahabag.
8. Genus *Microcoleus*	
M. chthonoplastes Thuret	In paddy fields, Rewas.
9. Genus *Schizothrix*	
(1) *S. mexicana* Gom. ..	On stones in a fast running streamlet, Saral.
(2) *S. porphyromelana* Bruehl et Biswas.	In a fast running streamlet, Zirad

Euglenophyceae

Name	Habitat and Locality
1. Genus *Euglens*	
(1) *E. acus* Ehr.	Common in bodhans.
(2) *E. proxima* Dong ..	In a Bodhan, Koproli.
2. Genus *Phacus* :	
(1) *P. acuminatus* Stok ..	In the ponds, Thal, Awas.
(2) *P. acuminatus* Stok. v. *triqueter* (E.) Dujardin.	In a pond, Dhokavade.

Name	Habitat and Locality
(3) *P. caudata* Hub ..	In a pond, Awas.
(4) *P. helikoides* Poch ..	In the ponds, Awas, Thal.
(5) *P. longicuada* (E) Duj. ..	In a pond, Thal.
(6) *P. meson* Poch.. ..	In a pond, Mapagaon.
(7) *P. orbicularis* Hubner..	In a pond, Dhokawade.
3. Genus *Lepocinclis*	
(1) *L. acuta* Pres	In a pond, Thal.
(2) *L. ovum* (Ehr.) Lemm.	In a pond, Awas.
(3) *L. ovum* (Ehr.) Lemm. v. *dimidio minor* Defl.	In a pond, Awas.
4. Genus Trachelomonas	
(1) *T. armata* (Ehr.) Stein v. *steinii* Lemm. emend. Defl.	In Bodhan, Koproli.
(2) *T. bulla* Stien emend. Defl.	In a pond, Dhokavade.
(3) *T. klebsii* Defl. ..	In a paddy fields, Rewas.
(4) *T. oblonga* Lemm. v. *truncata* Lemm. ..	In a Bodhan, Zirad.
(5) *T. volvocina* Ehr. ..	Common in bodhans and ponds.
(6) *T. volvocina* Ehr. v. *punctata* Playf. ..	In a pond, Mapagaon.
(7) *T. woycikii* Koez. ..	In a pond, Thal.

CHLOROPHYTA

Family Ulvaceae

1. Genus *Enteromorpha*	
(1) *E. prolifera.* Ag. ..	Attached to stone in a streamlet

Family Chaetophoraceae

2. Genus *Chaetophora*	
(1) *C. elegans* (Roth.) Agardh. ..	Adhering to stones in a paddy field outlet, Hashivare.
(2) *C. pisciformis* (Roth) Agardh.	Common in paddy fields and streamlets.
3. Genus *Stigeoclonium*	
(1) *S. tenus* (Agardh) Kuetz. ..	In a pond, Dhokavade.

Family Cladophoraceae

4. Genus *Cladophora*	
(1) *C. glomerata* (L.) Kuetz.	Attached to stones in a streamlet, Saral.
5. Genus *Pithophora*	
(1) *P. oedogonia* (Mont) .. Wittr.	In a well, Poynad.
6. Genus *Rhizoclonium*	
(1) *R. hieroglyphicum* (Agardh) Kuetz.	Planktonic in Khar paddy fields.

Family Coleochaetaceae

7. Genus *Coleochaete*.... ..

(1) *C. irregularis* Prings ..	Epiphytic on *Nitella* sp. in a pond, Kihim.
(2) *C. orbicularis* Prings ..	Epiphytic on *Nitella* sp. in a pond, Kihim.

Family Protococcaceae

8. Genus *Protococcus*

(1) *P. viridis* Agardh ..	On the leaves of *Sapota*, *Mangifera*, and on moist earthern pots.

Family Oedogoniaceae

9. Genus *Oedogonium*

(1) *O. ahlstrandii* Wittr. ex Hirn.	Epiphytic on *Chara sp* in a pond, in Kihim.
(2) *O. amomalum Hirn* ..	In a pool in a streamlet, Mapagaon.
(3) *O. zexuosum* Hirn. ..	In a slightly brackish water pond, Koproli.
(4) *O. pratense* Trans ..	In a pool, Saral.
(5) *O. subsexangulare* Tiff	Epiphytic on *Chara* in a pond, Kihim.
(6) *O. tapeinosporum* Wittr. ex. Hirn.	Attached to submerged cement wallin a pond, Mapagaon.
(7) *O. varians* Wittr. ex Hirn.	In a pool, Saral.
(8) *O. vaucherii* (Le Clero) Al. Braun.	Epiphytic on *Chara* sp. in a pond, Kihim.
(9) *O. virceburgense* Hirn	Epiphytic on *Chara* sp. in a pond, Kihim.

Family Hydrodictyaceae

10. Genus *Pediastrum*

(1) *P. duplex* Meyen *v. cohaerens* Bohlin. ..	In a pond, Dhokavade.
(2) *P. duplex* Meyen, *v. reticulatum* Lag.	In a pond, Thal.
(3) *P. simplex* (Meyen), Lemm.	Common in ponds, puddles.
(4) *P. tetras* (Ehr.) Ralfs	Common in ponds.
(5) *P. tetras* (Ehr.) Ralfs. *v,. tetradron* (Corda). Rab.	In a pond, Awas.

Family Oocystaceae

11. Genus *Ankistrodemus*

(1) *A. convolutus* Corda ..	In a pond, Awas.
(2) *A. falcatus* (Corda) Ralfs	Common in ponds.
(3) *A. falcatus* (Corda) Ralfs *v. tumldus* G. S. West.	In a pond, Awas.
(4) *A. spiralis* (Turn) Lemm.	In a pond, Thal.

Name	Habitat and Locality
12. Genus *Oocystis*	
(1) *O. borgei* Snow ..	Common in ponds
(2) *O. elliptica* W. West..	In a pond, Thal
13. Genus *Dimorphococcus*	
(1) *D. lunatus* A. Br. ..	In a pond, Thal
14. Genus *Selenastrum*	
(1) *S. guacile* Reinsh ..	In a pond, Dhokavade
15. Genus Tetraedron	
(1) *T. trigonum* (Naeg.) Hansg.	In paddy fields
Family Scenedesmaceae	
16. Genus *Scenedesmus*	
(1) *S. arcuatus* Lemm. v. *platydiscus* G. M. Smith.	In a pond, Awas
(2) *S. bijuga* (Turp.) Lag	Common in ponds
(3) *S. denticulatus* Lag ..	In a pond, Awas
(4) *S. falcatus* Chodat ..	In a pond, Dhokavade
(5) *S. incrassatulus* Bohlin v. *momonae* G. M. Smith.	On a dam, Tinvira
(6) *S. opoliensis* P. Richer	In a pond, Dhokavade
Family Desmidiaceae	
17. Genus *Closterium*	
(1) *C. acutum* Breb ..	In a pond, Thal
(2) *C. cornu* Ehr ..	In a pond, Poynad
(3) *C. dianae* Ehr. ..	In a pond, Thal
(4) *C. dianae* Ehr. v. *minus* (Wille) Schred.	In a pond, Thal
(5) *C. gracile* Breb ..	In a pond, Thal
(6) *C. gracile* Breb .. v. *intermedium* Ralf.	In a pond, Thal
(7) *C. kuetzingii* Breb ..	In a pond, Thal
(8) *C. parvulum* Naeg ..	In paddy fields, Saral
(9) *C. parvulum* Naeg .. v. *angustum* W. et. G. S West.	In a puddle, Mapagaon
(10) *C. venus* Kuetz ..	In a paddy fields, Saral
(11) *C. venus v. incurvum* (Breb.) Krieg.	In a pond, Kihim.
18. Genus *Cosmarium*	
(1) *C. amoenum* Breb ..	In a pond, Dhokavade
(2) *C. angulosum* Breb .. v. *concinnum* (Raben.) W.et. G. S. West.	In a pond, Kihim
(3) *C. bengalense* (Grun.) Turn.	In a pond, Dhokavade.

Name	Habitat and Locality
(4) *C. bioculatum* Breb v. *hians* W. et. G. S. West.	In a pond, Awas
(5) *C. contractum* Kirch	In a pond, Dhokavade
(6) *C. cyclicum* Lund f. *crenulatum* Kamat.	In a pond, Kihim
(7) *C. depressum* (Naeg.) Lund. v. *planktonicum* Rev.	In a pond, Kihim
(8) *C. furcatospermum* W.et G. S. West v. *koreanum* Skv.	In paddy fields, Saral
(9) *C. impressulum* Elfv	In a pond, Kihim
(10) *C. laeve* Rab ..	In a paddy fields. Saral
(11) *C. laeve* Rab v. *reniferme* Hir.	In mucilaginous mass on dripping wall at Tinvira. In a pond, Awas.
(12) *C. margaritatum* (Lund) Roy et Bisset. f. *minor* (Boldt) W. et G. S. West.	In a pond, Kihim
(13) *C. meneghinii* Breb ..	In the ponds, Awas, Kihim
(14) *C. moniliforme* (Trup.) Ralfs.	In a pond, Thal
(15) *C. occultum* Schm ..	In a pond, Kihim
(16) *C. perincissum* Gron v. *ahmedabadense* Kamat.	In a pond, Kihim
(17) *C. portianum* Arch ..	In a pond, Kihim.
(18) *C. punctulatum* Breb. *V. subpunctulatum* (Nord.) Boerg.	In a paddy field, Saral
(19) *C. rectangulare* Grunn v. *africanum* W. et G. S. West.	In a pond, Kihim
(20) *C. reniforme* (Ralfs) Arch. v. *conpreasum* Nord.	In a pond, Kihim
(21) *C. sikhimense* Turn ..	In a pond, Kihim
(22) *C. subturgidum* (Turn.) Schm. f. *minor* Schm.	In a pond, Thal
(23) *C. subtumidum* Nord v. *klebsii* (Gutw.) W. et. G. S. West.	In a pond, Kihim
(24) *C. tithophorum* Nord. v. *minor* Rac.	In a pond, Thal

19. Genus *Euastrum*

Name	Habitat and Locality
(1) *E. denticlatum* (Kirch.) Gay v. rectangulare W, et. G. S. West.	In a pond, Kihim

Name	Habitat and Locality
(2) *E. dubicum* Naeg. v. *tritum* W. et. G. S. West.	In a pond, Thal
(3) *E. irregulare* Gonz. et Gang.	On Tinvira Dam.
(4) *E. spinulosum* Defl ..	On Tinvira Dam.
(5) *E. Subalpinum* Messik	In a pond, Dhokavade.
(6) *E. substellatum* Nord	In a pond, Kihim
20. Genus *Staurastrum*	
(1) *S. deiectum* Berb ..	In a pond, Thal
(2) *S. oxyacauthum* Arch	In a pond, Thal
21. Genus *Desmidium*	
(1) *D. aptogonum* Breb v. *ehrenbergii* Kuetz.	In a pond, Thal

Family Zygnemataceae

22. Genus *Zygnema*	
(1) *Z. czurdas* Randh ..	In a paddy field, Saral
(2) *Z. gangeticum* Rao ..	Adhering to stones or free floating in a streamlet, Tinvira.
(3) *Z. hypnosporum* Rich	Planktonic in paddy fields on hills, Saral.
23. Genus *Spirogyra*	
(1) *S. daedaloide* Czurda	Floating masses in a pond, Kihim.
(2) *S. hyalina* Cleve ..	Common in ponds, paddy fields.
(3) *S. hymerae* Britt. et Smith.	In a pond, Mapagaon
(4) *S. singularis* Nord ..	In a streamlet, Saral

CHAROPHYCEAE

Family Characeae

1. Genus *Nitella*	
(1) *N. acuminata* A. Braun	Gommon in ponds, Awas, Zirad, Kihim, Thal.
(2) *N. axillaris* Braun ..	In a pond, Kihim
(3) *N. furcata* (Roxb. apod Bruz.) Agardh.	In ponds, Kihim, Awas
(4) *N. hyalina* (D.C.) Agardh.	Very common in Khar, paddy fields and in ponds.
(5) *N. watti* J. Grov ..	In a pond, Mapagaon
2. Genus *Chara*	
(1) *C. benthamii* A. Braun	In a pond, Kihim
(2) *C. brachypus* Braun ..	Common in ponds, paddy fields
(3) *C. corallina* Willd ..	Common in ponds
(4) *C. pseudobrachypus* Grov. et Steph.	In ponds, Saral, Awas
(5) *C. zeylanica* Willd ..	Very common and very variable species in Khar, paddy fields, ponds, pools.

13. ALGAE OF RATNAGIRI AND MALVAN

Family Ectocarpaceae

1. Genus *Ectocarpus*
   E. compger Lynbye

Family Dictyotaceae

2. Genus *Dictyopteris*
   D. woodwardii (Br.) J. Ag.
3. Genus *Spatoglossum* (Brown) Ag.
   S. marginatum (Ag.) Kuetz.
4. Genus *Padina*
   P. tetrastromatica Hauck.
5. Genus *Pocockiella*
   Pocockiella sp.

Family Punctariaceae

6. *Colpomenia*
   C. sinuosa (Roth) Derb. et Sol.

14. ALGAE OF PUNE

CYANOPHYTA

Family Chroococcaceae

1. Genus *Gloeocapsa*
   G. crepidinum Thuret .. Crust forming alga, Poona.
2. Genus *Merismopedia*
   M. minima Beck
3. Genus *Gloeothece*
   G. rupestris (Lyng.) Born.
4. Genus *Microcystis*
   M. aeruginosa (Kuetz.)
5. Genus *Scytonema*
   S. hansgirgi Schmidle
   S. pseudohofmanni Bharadw.

Family Nostochopsidaceae

6. Genus *Stigonema*
   S. ocellatum (Dillw.) Thuret In paddy fields at Poona.

Family Nostocaceae

7. Genus *Nostoc*
   N. microscopicum Carm.
8. Genus *Nostochopsis*
   N. lobatus Wood emend. Geitler
9. Genus *Anabaena*
   (1) *A. spiroides* Kelb.
   (2) *A. laxa* (Rabenh.) A. Br. In Western Ghats, Poona.

Family Oscillatoriaceae

10. Genus *Oscillatoria*
    (1) *O. personata* Skuja
    (2) *O. serpentina* Richler

11. Genus *Lyngbuya*
    L. majuscula Harv.

12. Genus *Phormidium* Kuetz.
    (1) *Phormidium* sp. .. On tree trunks at Poona.

CHLOROPHYTA

Family Euglenaceae

1. Genus *Eaglena*
   E. acus Ehrenb

Family Chaetophoraceae

2. Genus *Chaetophora*
   C. elegans (Roth) Agardh

3. Genus *Chaetonema*
   Chaetonemairregulare Meyen

4. Genus *Stigeoclonium*
   Stigeoclonium sp.

5. Genus *Achanochaete*
   A. polychaette (Hansg.) Fritsch

6. Genus *Fristchiella* Nordst
   F. tuberosa Iyengar

Family Cladophoraceae

7. Genus *Rhizoclonium*
   R. hierogyphicum Kuetz

Family Chlamydomonadaceae

8. Genus *Chlamydomonas* sp.
   Chlamydomonas sp.

9. Genus *Sphaerellopsis*
   S. Fluviatilis Pardllan

10. Genus *Carteria*
    C. ovata Jacobsen

11. Genus *Chlorogonium*
    C. tetragenium

12. Genus *Pamlorina*
    P. marum (Muell.) Bory.

13. Genus *Eudorina*
    E. elegans Ehrenb

14. **Genus *Volvox***

(1) *V. poonaensis* Apte
(2) *V. dissibatrix* (Shaw)
(3) *V. prolificus* Iyengar

Family *Chlorococaceae*

15. Genus *Chlorococcus*
Chlorococcus sp.

16. Genus *Chalorella*
C. vulgaris Beji.

17. Genus *Actinostrum*
A. hantzschii Lagerh

18. Genus *Kirchneriella*
K. lunaris (Krichn.) Moeb.

19. Genus *Sorashtrum*
Sorashtrum sp.

20. Genus *Micractinium:*
(1) *M. guadriselem* Lemn.
(2) *Micractinium* sp.

21. Genus *Trebauxia*
Trebauxia sp.

22. Genus *Protosiphon*
P. botryoides (Kuetz.) Klebs

Family Ulotricaceae

23. *Ulothrix Zonata* (Klebs)
24. Genus *Hormidium*
H. Flaccidum (Kuetz.) Br.

Family Sphaeropleaceae

25. Genus *Sphaeroplea*
S. annulina (Roth) Ag.

Family Ulvaceae

26. Genus *Ulva*
(1) *U. farceala* Delice
(2) *U. reticulata* Forssk
(3) *U. lactuca L.*

Family Tentapohliaceae

27. Genus *Gongroma*
G. circinata (Borzi) Schmidle

28. Genus *Cephaluros*
C. virescens Kunze

29. Genus *Pleurococcus*
P. naegelii. Chod.

Family Palmellaceae

30. Genus *Sphaerocystis*
    S. schroeteri
31. Genus *Pediastrum*
    P. duplex Meyer
32. Genus *Westella*
    W. botryoides Wildem

Family Oedogoniaceae

33. Genus *Oedogonium*
    O. capillare Kuetz.

Family Hydrodictyaceae

34. Genus *Hydrodictyon*
    H. reticulatum (L.) Lagerh.
35. Genus *Pediastrum*
    P. simplex Meyer

Family Oocystaceae

36. Genus *Ankistrodesmus*
    A. falcatus (Corda) Ralfs.
37. Genus *Dimorphococcus*
    D. lunatus A. Br.
38. Genus *Tetrastrum*
    T. elegans Playfair
39. Genus *Closterium*
    C. moniliferum Ehrenb.

Family Zygnemataceae

40. Genus *Spirogyra*
    Spirogyra spp.
41. Genus *Zygnema*
    Zygnema spp.

14·1. Algae of Pune and Vicinity

There are several algae at places near about Pune. Of these flora of ponds and tanks on the Purandar hill-fort, about 35.2 km., and in the pond at Bhosari is very interesting. It is from here that Apte (1936) reported species of *Volvox*. They perennate even if the ponds dry. The other algae found at Purandar are :—

Crucigenia cruciata, *Kirchneriella lunaris*, *Ankistrodesmus falcatus*, *Sirogonium sticticum*, *Sirocladium maharashtrense*, *Vaucheria sessilis*, species of *Cosmarium*, *Coelastrum*, *Euastrum*, *Fragillaria*, *Staurastrum*, *Chlorella*, *Chlorococcum*, *Pennularia*, *Navicula* *Characiosiphon*.

In the Mutha river with flowing water during the months of October-November one finds a species of *Bulbochaete*. On the margins of drying ponds near river on the silt one finds *Botrydium*. It will be seen from above the Pune is very rich in fresh water algae and it would be worthwhile investigating them thoroughly throughout occurring the year and compare them with those in other places like Kolhapur. In the early months of the monsoons one notices several species of *Spirogyra* and

later *Oedogonium*. The latter persists even during the dry months, should some water be available in the pond. They practically dominate the flora of the pond.

The list of other known algae is given below.

Algae of Pune Proper :

Pune stands at the confluence of the two small uphill rivers Mula and Mutha, rich in varied green and blue green algae. There are a few small lakes, which supply water to Pune at Katraj and Pashan and a number of small and large ponds having permanent sheets of water. Some are temporary monsoon ponds. They all contain a number of algae not fully investigated. From available information some of them are given below. They are all fresh water algae collected occasionally and not throughout the year.

14·2. ALGAE OF GANESHKHIND BOTANICAL GARDEN POND, ETC

This contains *Tetraedron trigonum*, *Pediastrum duplex*, *Ankistrodesmus falcatus*, *Tetraspora lammermannii*, *Scenedesmus quadricuada*, *Merismopedia glauca*, *Gleocystis ampla*, *Oscillatoria perornata*, *Pennularia viridis*, *Rhopalodia biloba*, *Nephrocytium agardhianum*, *Fritschiella tuberosa*, *Protosiphon botryoidis* and species of *Asterococcus*, *Anabaena*, *Desmidium*, *Closterium*, *Straurastrum*, *Straurodesmus*, *Cosmarium Pleurotenium*, *Chlamydomonas*, *Navicula*, *Ulothrix*, *Stigeoclonium*, *Mougeotia*, *Peridinium*, *Gymnodinium* etc.

There is a small pond at Kirkee on way to Kirkee station from Ganeshkhind Botanical Garden. It is a rain water pond, but never dries up. It contains *Pandorina murum*, *Nephrocytium lunatum*, *Coelosphaerium nagelianum Cylindrospermum gorakhporense*, *Botryococcus braunii*, *Aphanochaetae rapense*, *Schizomeris leiblenii*. Species of *Volvox*, *Bulbochaetae*, *Uronema*, *Oedogonium*, *Zygnema* etc.

The small lily pond in the Poona University campus garden has the following algae :—

Microcoleus, *Echthonoplostes*, and species of *Trebauxia*, *Pleurococcus*, *Haplosiphon*.

Swimming pool on the Pune University campus has *Scenedesmus dimorphus*, *Sirocladium maharashtraense* and species of *Colastrum*, *Chroococcus*.

A little further in a pond at Chatushringi the flora consists of *Eudorina elegans*, *Pediastrum boryeneum*, *Pediastrum tetrasvar*, *tetrahydron* and species of *Lyngbya*, *Cyclotella*, *Hormidium peranema*, *Westella*, *Oocystis Characium*. Occasionally one comes across a species of *Gongrosera* growing on the shells of water snails in the pond in the quarry of Gokhale nagar near Mhasoba Chouki.

15. ALGAE OF KOLHAPUR

(After N. D. Kamat, 1963, *Hydrobiologia*-22 (3-4) 209—305)

CYANOPHYTA

Family Chroococcaceae

Name	Habitat and Locality
1. Genus *Microcystis*	
(1) *M. aeruginesa* Kuetzing	Common in puddles, ponds (throughout the year).
(2) *M. flosaquae* (Wittr.) Kirchner along with *M. aeruginosa*.	In a pond, (5-11-53).

Name	Habitat and Locality
(3) *M. Pesudofilamentosa* Crow.	In a puddle, Rankala side (5-10-55).
(4) *M. scripta* (Richter) Lemm.	In a pond, Shahupuri (5-10-53)
2. Genus *Aphanocapsa*	
(1) *A. biformis* A. Br. ..	In dripping walls, (19-7-53).
(2) *A. fenticola* Hansgirg	In a streamlet, Takala (12-7-53).
(3) *A. grevillei* Rabenhorst	In a streamlet, Takala (12-7-53).
(4) *A. montana Cramer* ..	On dripping rocks, (19-7-1953).
(5) *A. muscicola* Meheghini Wille.	On dripping rocks, (19-7-1953).
(6) *A. nivalis* Lagerheim ..	On dripping rock, (19-7-1953).
3. Genus *Aphanothece*	
(1) *A. castagnei* (Breb.) .. Rabenhorst.	Common on dripping rocks barks of trees (July-August).
(2) *A. microscopica* Naegeli	In a pond, (6-3-1954).
(3) *A. naegeli* Wartm ..	In puddle, Takala ; Rankala lake side (30-8-1953).
(4) *A. pallida* (Kuetzing) Rabenhorst.	Common in globular amorphous masses in paddy fields, ponds ; On moist soils, dripping rocks. on barks of Banyan trees etc. (throughout the year).
(5) *A. saxicola* Naeg ..	On dripping rocks, (19-7-53).
4. Genus *Gloeotheca*	
(1) *G. geoppertiana* (Hilse) Forti.	On dripping rocks, (19-7-1953).
(2) *G. membranacea* (Rabenhorst) Bornet.	On dripping soil near streamlet, Takala (20-7-1953).
(3) *G. pales* (Kuetzing) Rabenh.	On moist soil near streamlet Takala (20-7-1953).
5. Genus *Chroococcus* Naegeli	
(1) *C. minutus* (Kuetzing) Naegeli.	In a well, Takala (6-3-1954).
(2) *C. spelaeus* Erceg ..	In a pond, Takala (6-3-1954).
6. Genus *Coelosphaerium* Naegeli	
Coelosphaerium goetzi Schemidle.	
7. Genus *Merismopedia* Meyen	
(1) *Merismopedia glauca* (Ehrenberg).	Common in puddles and ponds, (Jan.-May).
(2) *M. marssonii* Lemmermann.	The algae was found always in colonies of four cells only.
(3) *M. tenuissima* Lemm..	Common in puddles (January-March).

Name	Habitat and Locality
8. Family Microchaetaceae.	
Genus *Microchaete*	
M. uberrima Nacarter ..	Common on moist soil, on moist wall of a house, Takala, (5-7-53). In puddles, ponds, (5-9-53), (5-10-53), (5-5-1954).
9. Genus *Aulosira* Kirchner	
(1) *A. fertilissima* Ghose v. *tenuis* C. B. Rao.	In puddles by Rankala side (8-8-53).
(2) *A. implexa* Bornet et. Flahault v. *crassa* Dixit	Common in puddles, ponds, on moist soil (August-September).
Family Rivulariaceae	
10. Genus *Calothrix* Agardh	
(1) *C. fusca* (Kuetzing) Bornet and Flahault.	Common on dripping rocks, (10-10-53). On stones in a puddle Rankala lake side (8-1-1954).
(2) *C. karnatakensis* Gonzalves and Kamat.	In mucilagenous masses of *Chaetophora* sp. in a puddle, (2-9-1953).
(3) *C. karnatakensis* Gonzalves and Kamat. v. *major* Gonzalves & Kamat.	Embedded in the gelatinous mass of *Gloeotrichia* sp. in a puddle, (5-2-1954).
(4) *C. karnatakensis* Gonzalves and Kamat v. *Major* Gonzalves and Kamat. f. *varians* Gonzalves and Kamat.	Epiphytic on *Chara* sp. in Rankala lake (5-10-1953).
(5) *C. wembaeremsis* ..	Embedded in the mucilaginous mass of *Gloeotrichia* sp. in a puddle, Rankala side (1-3-53), (6-9-1953).
11. Genus *Gloeotrichia* Agardh	
(1) *G. aethiopica* W. and G. S. West.	In a puddle (5-5-1954).
(2) *G. pilgeri* Schemidle ..	On *Ceratophyllum* sp. in a puddle (8-1-1954).
(3) *G. pisum* Thuret ex Bornet Flahault.	Epiphytic on water plants in a puddle (8-1-1954).
(4) *G. raciborskii* Woloszynska.	Common in ponds, puddles paddy fields (Sep.-Feb.).
Family Scytonemataceae	
12. Genus *Tolypothrix*	
(1) *T. brevis* (Gardner) Geitler.	On the bark of *Cassia* sp. Takala (10-6-1953).
(2) *T. rechingeri* (Wille) Geitler.	On the moist soil, Takala (12-11-1953).

Name	Habitat and Locality
13. Genus *Scytonema*	
(1) *S. amplum* W. et. G. S. West f. *hibernica* W. West.	On dripping rocks, (20-10-1953).
(2) *S. bohneri* Schmidle ..	In a puddle, (5-9-1953).
(3) *S. ocellatum Lyngbye* ex Bornet et flahault.	On water plants in a pond, (6-9-1953).
14. Genus *Petalonema* Berkeley	
(1) *P. denusum* (A. Br.) Migula.	On moist soil, Takala (8-3-1953).
Family Nostocaceae	
15. Genus *Cylindrospermum*	
(1) *C. catenatum* Ralfs ..	As dirty black masses floating in a puddle, (12-12-53).
(2) *C. licheniforme* Kuetz. ex. Bornet et Flah.	In a small pond, (6-8-1953).
(3) *C. mainus* Kuetz. ex Bornet et Flahault.	On slopes, near a streamlet, Takala (31-8-1953); on moist soil near a pond, (6-9-53).
(4) *C. muscicola* Kuetz. ex Bornet and Flahault v. *longispora* Dixit.	On moist soil, Takala (7-9-53).
(5) *C. sphaerica* Prasad f. *cylindricum* Kamat.	In a puddle, Kolhapur.
(6) *C. stagnale* (Kuetzing) Bornet and Flahault.	On moist soils, Takala (31-8-53, 6-9-1953).
(7) *C. trichotospermum* Fremy.	In puddles, Rankala lake (6-9-1953).
Family Nostocaceae	
16. Genus *Nostoc*	
(1) *N. commune* Vaucher ex. Bornet & Flahault.	
(2) *N. ellipsosporum* (Desm.) Raben.	On moist soils, Takala (6-9-53). On moist soil, old Rajaram College garden (7-10-1953).
(3) *N. microscopicum* Carm. ex Bornet and Flahault.	On moist soil on a stone wall, Takala (6-8-1953).
(4) *N. minutum* Desm. ex Bornet and Flahault.	On moist soil, Takala (25-9-53).
(5) *N. piscinale* Kuetzing ex Bornet & Flahault.	On soil on a stone wall, Takala (15-8-1953).
(6) *N. spongiaeforme* Agardh ex Bornet and Flahault.	On moist soil, (16-9-1953).
17. Genus *Anabaena* Bory	
(1) *A. ambigua* C. B. Rao	Submerged in Rankala Lake (5-10-1953).
(2) *A. fuellebornii* Schmidle	Floating in puddles, (6-9-53).

Name	Habitat and Locality
(3) *A. inaegualis* (Kuetz.) Bornet and Flahault.	In puddles, (8-1-54, 5-5-1954).
(4) *A. mediocris* Gardner	Floating in a puddle, (6-9-1953).
(5) *A. mysorensis* Gonzalves and Kamat.	Floating in a puddle, (5-9-1953).
(6) *A. orientalis* Dixit ..	In a puddle, (5-10-1953).
(7) *A. sphaerica* Bornet and Flahault.	Common in puddles (January-February).
(8) *A. volzii* Lemmermann	(6-9-1953).

Family Oscillatoraceae

18. Genus *Arithrospira*

(1) *A. balkrishnanii* Kamat	In wells, Kolhapur (8-9-1954).

19. Genus *Spirulina*

(1) *S. major* Kuetzing ex Gomont.	Common in ponds, puddles (October-May).

20. Genus *Oscillatoria* Vaucher

(1) *O. acuta* Bruehl and Biswas.	On moist soil near a streamlet at Takala (12-7-1953).
(2) *O. amphibi* Agardh ex Gomont.	In the mucilagenous mass of *Gloeotrichia* sp. floating in a pond, Kolhapur (8-9-53).
(3) *O. amphigranulata* Van Goor f. *conia* Kamat.	On dripping, rocks, Kolhapur (19-7-1953).
(4) *O. amoena* (Kuetzing) Gomont of *Kolhapurensis* Kamat.	On moist soil, Kolhapur (8-1-1954).
(5) *O. amoena* (Kuetzing) Gomont f. *maharastrensis* Kamat.	In a puddle, Takala, Kolhapur (9-10-1953).
(6) *O. animales* Agardh ex Gomont.	In a puddle, Kolhapur (8-1-1954).
(7) *O. annae*van Goor ..	A form collected in the moist soil, Shahupuri.
(8) *O. annae*van Goor. f. *Major* Kamat.	On moist soil, Kolhapur (12-7-1953).
(9) *O. bharadwajae* Kamat	In a puddle, Takala. Kolhapur (5-5-1954).
(10) *O. biswasii* Kamat ..	Floating in a puddle, Kolhapur (1-3-1954).
(11) *O. bourrellyi* Kamat ..	In a puddle, Kolhapur (8-8-53).
(12) *O. brevis* (Kuetzing) Gomont v. *non-granulata* Kamat.	On moist soil near a waste water passage, Kolhapur (23-3-54).
(13) *O. chalybea* (Mertens) Gomont v. *Major* Kamat.	In a puddle, Kolhapur (8-8-53).
(14) *O. corakiana* Playfair v. *non-granulata* Kamat.	On moist soil, Kolhapur (12-7-1953).

Name	Habitat and Locality
(15) *O. cortiana* Meneghini ex Gomont. v. *miner* Kamat.	On moist soil, Takala, Kolhapur (20-7-1953).
(16) *O. decolorata* G. S. West.	In a drying puddle (21-3-1954).
(17) *O. formisa* Bory ex Gomont.	On moist soil, Shahupuri (2-10-53).
(18) *O. hamelii* Fremy f. *brevis* Kamat.	In a puddle, Kolhapur (8-3-1954).
19) *O. homogena* Fremy	On the bark of *Cassia* sp. (12-8-53) Floating in a puddle, or on the moist soil near a puddle, (20-8-1953).
(20) *O. limosa* Agardh ex Gomont v. *disperso-granulata* Schkarb.	On moist soil, Takala (19-7-53).
(21) *O. mitrae* Kamat ..	In a puddle, Kolhapur (2-10-53).
(22) *O. mougeotii* (Kuetzing)	Common on moist soild, in waste water passages, in puddles (September, November, January, February).
(23) *O. nigra* Vaucher ..	In a puddle, Takala (12-7-53).
(24) *O. okeni* Agardh ex Gomont.	Common on moist soils, paddy fields, puddles (June—August).
(25) *O.princeps* Vaucher ex Gomont.	On dripping rocks (19-7-53).
(26) *O. profunda* Kirchner f. *conica* Kamat.	In a streamlet, Kolhapur (20-10-1953).
(27) *O. prolifica* (Grev.) Gomont.	In a puddle (2-10-53).
(28) *O. pseudogeminata* G. Schmidle. f. *longa* Kamat.	In a puddle, Kolhapur (6-3-1954).
(29) *O. quadripunctulata* Bruehl and Biswas v. *unigranulata* R. N. Singh.	In a puddle (8-2-1954).
(30) *O. rosea* Utermohl ..	In a puddle (8-3-1954).
(31) *O. rubescens* D. C. ex Gomont.	Common on moist soils (throughout the year). On leaves of *Pistia* sp. in a puddle (25-7-1953).
(32) *O. rubescems* D. C. ex Gomont v. *curvala* Kamat.	On moist soil, Takala, Kolhapur (28-2-1954).
(33) *O. rubescens* D. C. ex Gomont v. *Kolhapurensis* Kamat.	On dripping rocks, Kolhapur (10-8-1953).
(34) *O. schultzii* Lemmermann v. *cylindrica* Kamat.	In rain water pool, Kolhapur (12-7-1953).
(35) *O. simplicissima* Gomont.	Floating in a pond (1-3-54).

Name	Habitat and Locality
(36) *O. suxenae* Kamat ..	In a pool, Kolhapur (5-10-54).
(37) *O. tambi* Woronich ..	Common on moist soils (July-September).
(38) *O. tenuis* Agardh ex Gomont.	Common on moist soils (July-September).
(39) *O. terebriformis* Agardh ex Gomont.	In a rain water pool, Takala (19-7-53). In a puddle, (8-2-1954).
(40) *O. yamadae* Kamat ..	In a puddle, Kolhapur (9-10-53).
21. Genus *Phormidium* Kuetzing	
(1) *P. ambigum* Gomont ..	In a streamlet, or on moist soil near a streamlet, Takala (20-7-1953).
(2) *P. anomala* C. B. Rao ..	In a streamlet, Takala (19-7-53) on submerged soil Rankala lake side (6-8-1953).
(3) *P. bohneri* Schmidle ..	On the bark of Coconut tree, Shahupuri (19-7-1953).
(4) *P. zylanicum* Wille v. *minor* Kamat.	On moist soil, Kolhapur (28-7-53).
(5) *P. corium* (Agardh) Gomont.	On moist soil near a streamlet Takala (6-8-53), on the moist soil Rankala side (8-9-53).
(6) *P. molle* (Kuetzing) Gomont. ..	On the bark of *Cassia* sp. Takala (1-8-55), on moist soil Takala (9-8-53). In a puddle Rankala side (8-1-1954).
(7) *P. musicola* Huber-Pestabzziet Naumann.	Along with *Microcystis* sp. in a puddle (19-7-1953).
(8) *P. papyraceum* Gomont..	On the bark of Coconut tree Shahupuri (12-7-1953).
(9) *P. pristleyi* Fristsch ..	On the bark of Coconut tree, Shahupuri.
(10) *P. stagina* Rao, C. B. v. *major* Kamat.	On the bark of *Thespesia* sp. Kolhapur (10-8-1953).
(11) *P. subincrustatum* Fritsch and Rich ..	On stones Rankala lake (19-7-53) The algae was not classified.
(12) *P. uncinatum* (Ag.) Gomont. ..	On the bark of *Pnhoenix* sp. Takala (16-7-1953).
(13) *P. viscosum* Lemmermann. ..	On the moist soil, Takala (29-8-53)
22. Genus *Lyngbya*	
(1) *L. aerugineo-coerulea* (Kuet.) Gomont.	Common on trees, Slopes, moist soils (July-November).
(2) *L. amphivaginata* Var. Goor	On dripping rocks (19-7-1953).
(3) *L. antartica* Gain v. *major* Kamat.	In a puddle, Kolhapur (5-5-54).

Name	Habital and Locality
(4) *L. attenuata* F. E. Fritsch.	On dripping rocks, (19-7-53) In a laboratory culture (26-7-1953).
(5) *L. brevissima* (Kuetzing) Hansgirg.	Epiphytic on filaments of the algae in a puddle, (5-5-1954).
(6) *L. digueti* Gomont ..	In a puddle, (8-1-54).
(7) *L. dixitii* Kamat ..	In a puddle, Kolhapur (10-10-53).
(8) *L. endophytica* Elenkin and Hollerb.	In the mucilaginous mass of *Aphanothece* sp. on dripping rock, (2-10-53).
(9) *L. fontana* (Kuetzing) Hansgirg.	On the bark of *Ficus* sp. Takala (6-8-1953).
(10) *L. gandhii* Kamat ..	Embedded in the mucilaginous mass of *Aphanothece pallida* on dripping rocks, Kolhapur (6-3-1954).
(11) *L. halophila* Hansgirg ..	On dripping rocks, (19-7-53, 2-10-1953).
(12) *L. kolhapurensis* Kamat	Epiphytic on *Cladophora* sp. growing on snails in a pond, Kolhapur (5-5-1954).
(13) *L. lachneri* (Zimmerman) Geitler.	Epiphytic on other algae in a puddle, (20-7-1953, 8-1-54, 5-5-1954).
(14) *L. lachneri* (Zimmerman) Geitler v. *minor* Kamat.	Epiphytic on snails in a pond Kolhapur (5-5-1954).
(15) *L. limnetica* Lemmermann.	In a puddle, (5-5-54).
(16) *L. maharastrensis* Kamat.	In a puddle, Kolhapur (2-10-53).
(17) *L. majuscula* Harvey ex Gomont.	In a puddle, (6-9-1953).
(18) *L. martensiana* Meneghini ex Gomont f. *rupestris* Fremy.	On moist soil, Takala (16-7-53).
(19) *L. mollischii* Vouk ..	In a puddle, (8-1-1954).
(20) *L. nigra* Agardh ex Gomont.	On moist soil, Takala (12-7-53).
(21) *L. nordyardhi* Wille ..	Epiphytic on *Rhizoclonium* sp.
(22) *L. perelegans* Lemmermann.	On dripping rocks, (19-7-53).
(23) *L. schmidlei* Kamat (*Lyngbya Kuetzingii* Schmidle).	Epiphyt on snails in a puddle, Kolhapur (5-5-1954).
(24) *L. semiplena* Agardh ex Gomont.	On the bark of *Phoenix* sp., Takala (16-7-1953).
(25) *L. shackletoni* W. et G. S. West.	In the mucilaginous mass of *Aphanothece* sp., (8-9-53).

Name	Habitat and Locality
(26) *L. stagina* Kuetzing *non-granulata* Kamat.	In the mucilagenous mass of *Aphanotheca* sp. on dripping rocks, Kolhapur (10-8-1953).
(27) *L. truncicola* Ghose ..	On the moist soil near a streamlet, Takala (12-7-1953).
23. Genus *Hydrocoleum* Kuetzing	
(1) *H. subincrustaceus* Hansgirg.	On moist soil, Takala (19-8-1953).
24. Genus *Microcoleus* Desmaziers.	On moist soils, Takala (9-8-53, 14-9-53, 28-2-1954).
(1) *M. amplus* Gardner v. *minor*.	On the bark of *Mangifera* sp., Kolhapur.
(2) *M. chthonoplastes* Thurst ex Gomont.	Common on moist soils, on slopes (July-October).
(3) *M. steenstrupli* Boye Petersen.	Common. On moist soils along the road, near the ponds, dirty water passages. (July—Oct.)
25. Genus *Symploca*	
(1) *S. muralis* Kuetzing ex Gomont.	On dripping rocks, (2-9-53).

EUGLENOPHYCEAE OF KOLHAPUR

Name	Habitat and Locality
1. Genus *Euglena*	
(1) *E. acus* Ehrenberg ..	In a puddle, (8-1-1954).
(2) *E. fusca* (Klebs) Lemm	In puddles, Takala (5-10-53, 5-5-1954).
(3) *E. heimii* Lefeuse ..	In a dirty water pool, Takala, (5-10-1953).
(4) *E. maharastrensis* Kamat.	In a pond, Kolhapur (6-3-1954).
(5) *E. multiformis* Schiller	In a puddle, (5-5-1954).
(6) *E. oxyris* Schmarda ..	In a puddle, (6-3-54, 5-5-54).
(7) *E. rustica* Schiller ..	In a pond, (6-3-1954).
(8) *E. sacculiformis* Schiller	In a dirty water pool, (20-10-1953).
(9) *E. tuberculata* Swir ..	In a puddle, (8-1-1954).
2. Genus *Lepocinclis* Perty.	
(1) *L. ovum* (Ehrenberg) Lammermann.	In a puddle, (1-3-1954).
(2) *L. salina* Fritsch v. *ahmedabadensis* Kamat	In a puddle, (5-5-1954).
3. Genus *Phacus* Dujardin	
(1) *P. acuminatus* Stokes	Common in puddle (October-November).
(2) *P. caudatus* Huebner ..	In a puddle, (1-10-1953).
(3) *P. curvicauda* Swirenke	In a puddle, (6-3-1954).

Name	Habitat and Locality
(4) *P. hameli Allorge* and Lefevre.	In a dirty water pool, Takala (5-10-1953).
(5) *P. horridus* Pochmann	In a dirty water pool, Takala (5-10-1953).
(6) *P. longicauda* (E). Dujardin.	In a puddle (5-10-1953) (5-5-1954)
(7) *P. onyx* Pochmann ..	In a pool (21-3-1954).
(8) *P. pleuronects* (O. F. M.) Dujardin.	In a dirty water puddle, Shahupuri (8-1-1954).
(9) *P. suecicus* Lemmermann.	In a dirty water pool, Takala (5-10-1953).
(10) *P. tortus* (Lemm.) Skvertzov.	In a dirty water pool, Takala (5-10-1953).
(11) *P. ungus* Pochmann ..	In a shaded pool, Takala (1-3-54). In a puddle (5-5-1954).

4. Genus *Trachelomonas*

(1) *T. armata* Stein v. *steinii* Lemm. emend Deft.	In a puddle (2-10-1953, 5-5-1954).
(2) *T. desikacharyi* Kamat	In a puddle, Kolhapur (6-10-1953).
(3) *T. cordata* (Drez.). Comb. Deflandre f. *minor* Deflandre.	In a puddle (5-5-1954).
(4) *T. hispida* (Perty) Stein emend. Deflandre.	In a puddle, Takala (8-2-1954.)
(5) *T. hispida* (Perty) Stein emend; Deflandre f. *minor* Bourr.	In a puddle, Takala.
(6) *T. oblonga* Lemm. ..	In a puddle, Shahupuri (5-10-1953)
(7) *T. ovalis* Daday v. *maharashtrensis* Kamat	In a puddle (7-10-1953).
(8) *T. phulcherrima* Playfair	In a puddle (7-10-1953).
(9) *T. superba* Swiremend Deflandre.	In a dirty water pool (8-1-54). (5-10-1953).
(10) *T. sydneyensis* Playfair	In a dirty water pool, Takala.
(11) *T. volvocina* Ehrenberg	Common, in a dirty water ponds and puddle, Takala (Jan. 1954).

5. Genus *Strombomonas* Deflandre

S. urceolata (Stokes) Deflandre v. *kolhapurensis* Kamat.	In a puddle, Kolhapur (6-3-1954).

Family Astasiaceae

6. Genus *Astasia* Ehrendberg

(1) *A. ovalis* Huber-pestalozzi.	In a puddle (1-3-1954).

7. Genus *Menoidium* Perty

(1) *M. cultellus* E. G. Prinsheim.	In a puddle, Rankala side (1-3-1954).

CHLOROPHYCEAE OF KOLHAPUR

Names	Habitat and Locality
Family Palmellaceae	
1. Genus *Gloeocystis*	
(1) *G. ampla* (Kuetz) Lagerheim.	In a small pond (5-5-1954).
(2) *G. gigas* (Kuetz) Lagerheim.	In a puddles, small ponds, Takala (January-April).
Family Ulotrichaceae	
2. Jenus *Ulothrix*	
Ulothrix aegualis Kuetz ..	In a streamlet Takala (20-7-53), Rankala lake side in small water reservoir (20-10-1953).
Family Cylindrocapsaceae	
3. Genus *Cylindrocapsa*	
C. geminella Wolle ..	In a puddle, Rankala side (5-10-53).
Family Chaetophoraceae	
4. Genus *Stigeoclonium*	
S. labricum (Dilnoyn) Kuetz	Takala (16-7-53). In a puddle (2-9-1953).
5. Genus *Chaetophora*	
C. elegans (Roth) C. A. Agardh.	In a puddle.
Family Protococcaceae	
6. Genus *Protococcus*	
P. viridis Agardh.	
Family Coleochaetaceae	
7. Genus *Coleochacte*	
(1) *C. irregularis* Pringsheim.	In a puddle, Rankala lake.
(2) *C. orbicularis* Pringsheim.	
(3) *C. scutata* De Brebisson	
Family Ulvaceae	
8. Genus *Enteromorpha*	
1. *E. proligera* (Fl. Dan.) Agardh.	In a puddle, Rankala lake side
Family Cloophoraceae	
9. Genus *Clodophora*	
Calliconia Kuetzing.	
10. Genus *Pithophora*	
P. oedogonia (Mont.) Wittrock.	In puddles, ponds.

Name	Habitat and Locality
11. Genus *Rhizoclonium*	
R. hieroglyphicum (C. A. Agardh), Kuetz	In puddles, ponds.
Family Oedogoniaceae	
12. Genus *Oedocladium*	
Oedocladium sp	On moist soil.
13. Genus *Bulbochaete*	
B. brevifulta Wittrock ex Hirn	In a puddle, Takala (8-8-1953).
14. Genus *Oedogonium*	
(1) *O. abbreviatum* (Hirn) Tiffany v. *maius* Kamat	Epiphytic on leaves of water plants in a small pond, Takala (6-9-1953).
(2) *O. capillare* (L.) Kuetz. ex Hirn	In a pond, (5-9-1953).
(3) *O. capilliforme* Kuetz. Wittrock ex Hirn. v. *nanum* Randhwa	Free floating or adhering to water plants in a rain water pool Takala.
(4) *O. consociatum* Collins and Hirvey v. *Kolhapurense* Kamat	Rankala lake.
(5) *O. costatosporum* Jao	In a rain water pool, Takala (12-7-1953).
(6) *O. epiphyticum* Transeu and Tiffany Geminhandl	In a puddle, Takala (1-3-1954).
(7) *O. edogonium formosum* Kamat	In a puddle, Kolhapur (8-2-1954).
(8) *O. gelatinosum* Kamat	In Rankala lake, Kolhapur (5-10-1953).
(9) *O. geminatum* Kamat	In a pool, Kolhapur.
(10) *O. glabrum* Hallas f. *maharashtrense* f.	(30-8-53) (7-10-53). In *wadis* Kolhapur.
(11) *O. hatei* sp. nov. ..	In a small pond, Kolhapur (8-2-1954).
(12) *O. hindustonense* Kamat	In a pond, Kolhapur (6-9-53).
(13) *O. imahorii* Kamat ..	In a pond, Kolhapur (8-9-1953).
(14) *O. intermedium* Wittrock ex Hirn.	In ponds, puddles, streamlets (July-August); on moist soil, Takala (12-7-1953).
(15) *O. kirtikarii* Kamat ..	In Rankala lake, Kolhapur (5-10-1953).
(16) *O. kolhapurense* Kamat	In a pool, Takala (5-10-53).
(17) *O. lammermannii* Tiffany	In a pool, Takala (5-10-1953).
(18) *O. longipilum* Jao ..	Epiphytc on *Chara* sp. in Rankala lake (5-10-53). Floating in a puddle, Rankala side.
(19) *O. maharashtrense* Kamat	In a puddle, Kolhapur (8-1-54).

Name	Habitat and Locality
(20) *O. minus* Wittrock ex Hirn	In a puddle, Rankala side (8-1-54).
(21) *O. nankingense* Jao ..	Floating in a small pond, (8-2-1954).
(22) *O. oyei* Kamat ..	In a pool, Kolhapur (8-1-1954).
(23) *O. paucostriatum* Tiffany	Common in ponds, puddles, Takala (August-September).
(24) *O. plagiostomum* Wittrock ex Hirn	In a puddle, (8-1-1954).
(25) *O. prescotti* Kamat	In a puddle, Kolhapur (8-8-53).
(26) *O. princeps* (Hassall) Wittrock ex Hirn	In a puddle, Kolhapur.
(27) *O. pringsheimii* (Cramer); Wittrock ex Hirn	In a puddle, Kolhapur.
(28) *O. pseudospirala* Nygaard	In puddles, ponds, Rankala side (August, September 1953, January 1954).
(29) *O. repens* Kamat ..	In a streamlet, Kolhapur(8-8-53).
(30) *O. robustrum* Tiffany	In a small pond, (6-9-1953).
(31) *O. rugulosum* Nordstedt ex Hirn	Common in ponds, Rankala side (January-April).
(32) *O. santapaui* Kamat ..	Epiphyte on *Chara* sp. in Rankala lake (5-10-1953).
(33) *O. santurnse* Tiffany ..	In a pond, (5-5-1954).
(34) *O. singhii* Kamat ..	In a puddle, Kolhapur (5-10-53).
(35) *O. spirale* Hirn v. *majus* Singh	In a pond, (5-9-1953).
(36) *O. stephensiae* Tiffany	In a puddle, (8-1-54), (5-5-1954).
(37) *O. tapeinosporum* Wittrock ex Hirn	In a puddle, (8-1-1954).
(38) *O. undulatum* (Brebisson) A. Braun; Wittrock ex Hirn	In a small pond, (5-9-1953).
(39) *O. unisporum* sp. nov.	In a puddle, Kolhapur (6-9-1953).
(40) *O. vaucherii* (Le Clarc) A. Braun, Wittrock ex Hirn	In puddle, Kolhapur (6-9-1953)

Family Chlorococcaceae

15. Genus *Characium*

(1) *C. rostratum* Reinhard ex Printz.	In a puddle, Rankala side (5-10-53)

16. Genus *Characiosiphon*

(1) *C. rivularis* Iyengar ..	Takala (August-September).

Family Hydrodictaceae

17. Genus *Hydrodictyon*

(1) *H. reticulatum* (L.) Lagerheim	Common in puddles, (July-September).

Name	Habitat and Locality
18. Genus *Pediastrum*	
(1) *P. clathratum* (Schroeter) Lemmermann	In a pond, (5-5-1954).
(2) *P. deplex* Meyen v. *clathratum* (A. Braun) Lagerheim	In a puddle, (5-5-1954).
(3) *P. muticum* Kuetzing v. *crenulatum* (Prescott).	In a pond, (6-9-1953).
(4) *P. ovatum* (Ehrbg.) A. Braun	In a puddle (8-1-1954).
(5) *P. simplex* (Meyen) Lemmermann v. *duodenarium* (Bailey) Rabenh.	In a small pond, Rankala side
(6) *P. tetras* (Ehrenberg) Ralfs.	Common, in puddles small ponds, Rankala lake side.
19. Genus *Sorastrum*	
S. spinulosum Naegeli ..	In puddles, Rankala lake side (5-9-53, 16-10-1953).

Family Coelastraceae

20. Genus *Coelastrum*	
C. microsporum Naegeli ..	Common in pools, puddles, ponds (August-October, March-May 1954).

Family Oocystadeae

21. Genus *Ankistrodesmus*	
(1) *A. falcatus* (Corda) Ralfs	Common in puddles (September-October 1953).
(2) *A. fractus* (West and West) Brunn.	In a pond, (6-9-1953).
(3) *A. spiralis* (Turner) Lemmermann	
22. Genus *Dimorphococcus*	
D. lunatus A. Braun. ..	In pools, puddle, Takala, Rankala side (5-10-53), (1-3-1954).
23. Genus *Gloeotaenium*	
G. loitelsbergeanum Hansgirg.	In puddles, ponds.
24. Genus *Kirchneriella*	
K. lunaris (Kirchner) Moebius	In pools, puddles, Rankala side (5-10-53, 17-3-1954).
25. Genus *Oocystis*	
(1) *O. borgi* Snow ..	In a pond, (6-9-1953).
(2) *O. elliptica* W. West ..	In a pool, (6-9-1953).
(3) *O. gigas* Archer ..	In a puddle, Rankala side (5-10-1953).

Name	Habitat and Locality
(4) *O. Kolhapurensis* Kamat	In puddles, Kolhapur (5-10-53).
(5) *O. maharashtrensis* Kamat	In puddles, Kolhapur (5-10-1953).

26. Genus *Tetraedron*

(1) *T. muticum* (A. Braun) Hansgirg	In a puddle, (5-5-1954).
(2) *T. muticum* (A. Braun) Hansgirg f. *punctulatum* (Reinsch) De Toni	In a puddle, (5-5-1954).
(3) *T. trigonum* (Naegeli) Hansgirg v. *tetragonum* (Naegeli) Rabenh.	In a puddle (5-5-1954).

27. Genus *Trachisca* Kuetzing

1. *T. granulata* (Reinsch) Hansgirg	In puddles, (8-1-54, 5-5-54).

Family Scenedesmaceae

28. Genus *Scenedesmus*

(1) *S. abundans* (Kirchner) Chotat v. *brevicauda* Smith	In a puddle, (5-5-1954).
(2) *S. abundans* (Kirchner) Chotat v. *indica* Kamat	In a pond, Kolhapur (2-10-1953).
(3) *S. abundans* Chotat v. *spicatus* (West and West) Smith.	In a pool, Rankala side (2-10-53).
(4) *S. arculatus* Lemmermann	In a pond, Takala (20-10-1953).
(5) *S. arculatus* Lemmermann v. *platydisca* Smith	In a puddle, Rankala side ponds (5-10-53, 5-5-1954).
(6) *S. bicaudatus* (Hansg.) Chotat.	Common in puddles, ponds (October 1953, January-May 1954).
(7) *S. bujuga* (Turp) Lagerheim v. *irregularis* (wille) Smith	Common in puddles (November-May) (6-3-1954).
(8) *S. brasiliensis* Bohlin ..	In a puddle, Takala, Rankala.
(9) *S. denticulatis* Lagerheim v. *Kolhapurensis* Kamat	In a pond, Kolhapur (8-8-1953).
(10) *S. dimorphus* (Turp.) Kuetzing	Common in puddles, ponds (Oct.-November, 1953, February-May 1954).
(11) *S. faldatus* Chota v. *major* Kamat	In a pond Kolhapur (6-5-1954).
(12) *S. kolhapurensis* Kamat	In a puddle, Kolhapur (8-1-1954).
(13) *S. longus* Meyen v. *brevispina* Smith.	In laboratory cultures, from a streamlet, Takala (8-8-1953).
(14) *S. longus* Meyen v. *dispat* (De Breb.) Smith	In a puddle (2-9-1953).

Name	Habitat and Locality
(15) *S. maharashtrensis* Kamat	In *Vadis*, Kolhapur (7-2-1954)
(16) *S. margalefii* Kamat ..	In puddles, Kolhapur (12-10-53).
(17) *S. obliqus* (Turp.)Kuetzing	In a pond, Takala, Rankala lake. (2-9-53, 5-10-53, 5-5-1954).
(18) *S. opoliensis* Richter ..	In a pond, Takala, Rankala.
(19) *S. quadricauda* (Turp.) De Breb. v. *longispina* (Chotat) Smith.	In a puddle, (5-5-1954).
(20) *S. quadricauda* (Turp.) De Breb. v. *maximum* West and West	In a pond, (5-5-1954).
(21) *S. quadricauda* (Turp). De Breb. v. *westii* Smith	In puddles by Rankala side.

Family Mesotaeniaceae

29. Genus *Cylinadrocystis*

(1) *C. minutissima* Turner v. *kolhapurensis* Kamat	On dripping rocks, Kolhapur (9-1-1954).

30. Genus *Mesotaenium* Naegeli

(1) M. *macrococcum* .. (Kuetz.) Roy and Bissett v. *micrococcum* (Kuetz.) West and West	On dripping rocks, Takala (9-8-53).
(2) *M. micrificum* Arch. West and West	On dripping rocks, Takala (9-7-53).

Family Desmidiaceae

31. Genus *Closterium* Nitzsch

(1) *C. ehrenbergii* Meneghini f. *attenuatum* Kamat	In a puddle, Kolhapur (21-8-53).
(2) *C. dianae* Ehrenberg ..	In puddle, (2-10-53).
(3) *C. kolhapurense* Kamat	In a pool, Kolhapur (5-10-53).
(4) *C. kolhapurense* Kamat v. *minus* var. nov. Kamat	In a pool, Kolhapur (5-10-53).
(5) *C. lanceolatum* Kuetzing West and West	Common in puddles, water reservoirs (Sept.).
(6) *C. maharastrense* .. Kamat	In a puddle, Kolhapur (8-2-54).
(7) *C. moniliferum* (Bory) Ehrenberg West and West	Common in pools, puddles (September-October).
(8) *C. parvulum* Naeg. West and West	In a small puddle, (5-5-54).
(9) *C. rectimarginatum* .. Scott and Prescott	In a small pond, Kolhapur (8-1-54).
v. *majus* Kamat	In a puddle, Parva, Kolhapur (8-1-54).

Name	Habitat and Locality
(10) *C. venus* Kuetzing West and West	Common in pools, puddles (September-October).
32. Genus *Pleurotaenium* Naegeli	
(1) *P. eugeneum* (Turner) West and Prescott.	In the mucilage of *Nitella* sp. in a puddle, Takala (5-10-53).
(2) *P. trabecula* (Ehrenberg) Naegeli f. *clavata* (Kuetzing) West and West	In a puddle, (6-9-53).
(3) *P. trabecula* (Ehrenberg) Naegeli v. *elongatum* Cedergren	Common in a pool (Jan-March)
(4) *P. trabecula* (Ehrenberg) Naeg. v. *rectum* (Delp.) West and West	In Rankala lake (5-10-53).
33. Genus *Cosmarium* Corda	
(1) *C. amoenum Brebisson* West and West	On dripping rocks, (9-8-53).
(2) *Cosmarium cucumis* Brebisson v. *attenuatum* G. S. West.	In a puddle, Takala (6-9-53).
(3) *C. dentiferum* Corda v. *minus* Kamat	Common in puddles, ponds, (September-October)January 54.
(4) *C. granatum* Brebisson Irenee-Marie	Embedded in the mucilaginous mass of *Aphanothece* sp. on dripping rock. (9-8-53). In a puddle, Takala (6-9-53).
(5) *C. hammeri* Reinsch West and West	In a shaded puddle, (March 1953).
(6) *C. impresulum* Elfv. West and West	Common in pools, puddles (January-May).
(7) *C. laeve* Rabenhorst West and West	On moist soil, Shahupuri (12-8-53), In a small puddle, (8-1-54).
(8) *C. lundellii* Delp. West and West	In a puddle, (5-9-53).
(9) *C. maharastrense* .. Kamat	On dripping rocks, Kolhapur. (21-8-53).
(10) *C. obtusatum* Schmidle	In a puddle, Rankala lake side (28-2-54).
(11) *C. pachydermum* Lund v. *aethiopicum* West and West	Embedded in the mucilaginous mass of *Gloeotrichia* sp. floating in a pond, (5-9-53).
(12) *C. subcucumis* Schmidle	Rare. In Rankala lake (8-1-54).
(13) *C. subimpressulum* .. Borge	Common in puddles, ponds (January-April).
(14) *C. subprotumidum* Nordstedt West and West	In a water reservoir, Takala (12-7-53).

Name	Habitat and Locality
(15) *C. subretusiforme* West and G. S. West v. *maius* Kamat	In a pond, Kolhapur (8-1-54).
(16) *C. subtumidum* Nordstedt f. *minor* Krieger	In a pool, (5-10-53). In a pond, Takala (8-5-54).
(17) *C. tumens* Nordstedt ..	In a pond, Takala (5-10-53). On moist soil of a drying puddle, (6-3-54).
(18) *C. undulatum* Corda ..	On moist soil, old Rajaram College garden (28-2-54).
(19) *C. undulatum* Corda v. *minutum* Wittrock	In the squeezings of the leaves of water plants, (6-9-53). In a pool, (2-10-53).
(20) *C. undulatum* Corda v. *wollei* West	On moist soil near a streamlet, Takala (12-7-53).
(21) *C. venustum* (Breb.) Arch. f. *minor* Wolle.	In a drying pond, (5-5-54).
(22) *C. vexatum* West ..	Common in puddles, ponds, streamlets (September-October).

34. Genus *Euastrum* Ehrenberg

(1) *E. binale* (Turp.) Ehrenberg ..	In the squeezings of the water plants in a pond, (6-9-53).
(2) *E. binale* (Turp.) Ehrenberg ..	On moist soil near a streamlet (6-9-53).
(3) *E. spinulosum* Delp. ..	Common in puddles, ponds (October 1953, March 1954).

35. Genus *Staurastrum* Meyen

(1) *S. gamelliparum* Nordstedt. ..	In a puddle, Takala (8-8-53).
(2) *S. gracile* Ralfs v. *nannum* Wolle, West and Carter	In a puddle, Rankala side (5-10-53).
(3) *S. punctulatum* Brebisson. ..	In a puddle, (27-5-54).
(4) *S. punctulatum* Brebisson v. *ellipticum* Lewin *forma* Krieger ..	In a drying pond, (5-5-54).

36. Genus *Hyalotheca* Ehrenberg

H. dissiliens (Sm.) Brebisson v. *hians* Wolle	Adhering to the roots of aquatic plants in a pond, (8-8-53).

37. Genus *Desmidium* C. A. Agardh

D. aptogonum Brebisson v. *ehrenbergii* Kuetzing	Common in puddles, ponds (August-September 1953, January 54).

Name	Habitat and Locality
Family Zygnemataceae	
38. **Genus** *Mougeotia* (Agardh) Wittrock.	
(1) *M. floridana* Transeau	In a puddle, (5-9-53).
(2) *M. poinciana* Transeau v. *minor* Kamat	In a puddle, Kolhapur (26-8-53). In *Vadis*, Kolhapur (26-8-53).
39. Genus *Spirogyra*	
(1) *S. africana* (Fritsch) Czurda f. *major* Kamat	In a puddle, Takala, Kolhapur (30-8-53). In *Vadis*, Takala, Kolhapur, (30-8-53).
(2) *S. azygospora* Singh v. *inflata* Kamat	Floating in a puddle, (6-9-53).
(3) *S. chakiaense* (Rao) Krieger	In Rankala lake (5-10-53).
(4) *S. communis* (Hassall) Kuetzing	In a pond, (5-5-54).
(5) *S. daedalea* Lagerheim	In a pool, (30-8-53). In a pond, Takala (5-5-54).
(6) *S. dubia* Kuetzing ..	In a puddle, (8-1-54).
(7) *S. fuellebornei Schmidle*	In a puddle, (5-5-54).
(8) *S. hautillensis* Transeau v. *Kolhapurensis* v. nov.	In a pond, Kolhapur (25-12-53). In a lake, Kolhapur (25-12-53).
(9) *S. hyalina* Cleve ..	In a puddle, (5-5-54).
(10) *S. indica* Krieger ..	In a puddle (8-1-54).
(11) *S. kolhapurensis* sp. nov.	In a puddle, Kolhapur (8-8-53) In *Vadis*, Kolhapur (8-8-53).
(12) *S. liana* Transeau ..	In a puddle, Rankala side (8-1-54).
(13) *S. longata* Krieger ..	Floating in a pond, Rankala side (6-9-53).
(14) *S. majuscula* Kuetzing v. *inflata* v. nov.	In a puddle, Takala, Kolhapur (1-3-54). In *Vadis*, Takala, Kolhapur (1-3-54).
(15) *S. maxima* (Hassall) Wittrock.	Floating in a puddle, (5-9-53 ; 8-1-54).
(16) *S. neglecta* (Hassall) Kuetz.	In a puddle, (20-10-53).
(17) *S. nitida* (Dillwyn) Link	Common in puddles, ponds (September-October).
(18) *S. setiformis* (Roth) Kuetz.	In puddles, Takala (5-9-53).
(19) *S. singularis* Nordstedt v. *major* v. nov.	In a puddle, Kolhapur (8-1-54). In *Vadis*, Kolhapur (8-1-54).
(20) *S. speciana* Rabehorst	In a streamlet, Takala (20-9-53). In a puddle, (8-1-54).
(21) *S. submaxima* Transeau	Common in puddles, ponds, (September-October 1953 ; January-March 1954).

Name	Habitat and Locality
40. Genus *Sirocladium* Randhawa	
(1) *S. kumaoense* Randhawa.	On moist soil, Rajaram College garden (29-9-53).
41. Genus *Zygnema* C. A. Agardh	
(1) *Zygnema insigne* (Hassall) Kuetz. ..	In a puddle, (8-8-53).
(2) *Z. kolhapurense* Kamat	In a puddle, Takala, Kolhapur (8-8-53). In *Vadis*, Takala Kolhapur (8-8-53).
(3) *Z. maharashtrense* Kamat. ..	In a puddle, Kolhapur (8-8-53). In *Vadis*, Kolhapur (8-8-53).
(4) *Z. momoniense* W. West.	Common in puddles, ponds (September-October 1953) ; (January 1954).
(5) *Z. sterile* Transeau ..	In a puddle, (August-September 1953).

CHAROPHYTA OF KOLHAPUR

Family Characeae

1. Genus *Nitella* A. Braun	
(1) *N. acuminata* A Braun	In a pond, Takala (5-10-53). In a puddle Rankala side (8-1-54).
(2) *N. batrachosperma* (Reichenback) A. Braun.	In a puddle, Rankala (5-10-53), (8-1-54).
(3) *N. furcata* (Roxburgh apud (Burzelius) Agardh.	Common in puddles (September-October).
(4) *N. leptodactyla* J. Groves.	In a puddle, Rankala side (8-1-54).
2. Genus *Chara* Vallient	
(1) *C. brachypus* A. Braun. ..	In puddles, Takala (September).
(2) *C. globularis* Thiller ..	In a drying pond, (6-3-54).
(3) *C. vulgarks* Linnaeus	Common in puddles, ponds (October-November 1953).

16. ALGAE OF PANHALA

(After N. D. Kamat)

CYANOPHYCEAE

Family Chroococcaceae

1. Genus *Aphanocapsa.*

(1) *A. biformis* A. Hr.

(2) *A. fusolujtea* Hansgirg.

(3) *A. grevillei* (Hass.) Rabenhorst.

(4) *A. muscicola* (Meneghini) Wolle.

Name | Habitat and Locality

(5) *A. roseana* de Bary.

(6) *A. costagnei* (Breb.) Rabenhorst.

(7) *A. pallida* (Kuetzing) Rabenhorst.

2. Genus *Chroococcus*

(1) *C. montanus* Hansgirg.

(2) *C. turicensis* (Naegeli) Hansgirg.

Family Rivulariaceae

3. Genus *Gloeotrichia*

G. raciborskii Woloszynska.

4. Genus *Rivularia.*

R. *maharashtrensis* Kamat.

Family Microchaetaceae

5. Genus *Microchaete*

M. tenera
Thuret ex Born. et Flah.

Family Scytonemaceae

6. Genus *Tolypothrix.*

T. robusta Gardner.

7. Genus *Scytonema*

(1) *S. lyngbyoides* Gardner.

(2) *S. stuposum* (Kuetzing).
Born. at Flah.

Family Nostocaecae

8. Genus *Cylindrospermum*

(1) *C. stagnale* (Kuetzing) Bornet Flah.

(2) *C. stagnate* (Kuetz) Born. et Flah *v. minus* Kamat.

9. Genus *Nostoc*

(1) *N. commune* Voucher ex Born. et Flah.

(2) *N. microscopicum* Carm. ex Born. et Flah.

(3) *N. piscinale* Kuetzing ex Born. et Flah.

10. Genus *Nodularia*

N. harveyana Thuret.

Family Oscillatoriaceae

11. Genus *Oscillatoria*

(1) *O. brevis* (Kuetz.) Gomont.

(2) *O. granulata* Gardner v. *major* Kamat.

(3) *O. maharastrensis* Kamat.

(4) *O. pseudogeminata* G. Schmid.

(5) *O. terebriformis* Agardh ex Gomont.

Name	Habitat and Locality
17. ALGAE OF MAHABALESHWAR	
EUGLENOPHYTAA	
1. Genus *Trachelomonas* Ehren.	
T. hispida (Perty) Stein emend. Deflandre v. *duplex* Deflandre.	Floating along with other alga in Venna lake.
CYANOPHYCEAE	
Family Chroococcaceae	
1. Genus *Aphanocapsa* Naegeli	
(1) *A. musicola* (Meneghini) Wille.	On dripping rocks.
(2) *A. bullora* (Meneghini) Rabenherst.	On dripping rocks.
(3) *A. castegnei* (Brebisson) Rabenherst.	On dripping rocks.
(4) *A. pallida* (Kuetz.) Rabenherst.	In a pond.
2. Genus *Chroococcus* Naegeli	
(1) *C. minutes* (Kuetzing) Naegeli.	On dripping rocks cells solitary or in twos.
(2) *C. turicensis* (Naegeli) Hansgirg.	On dripping rocks.
3. Genus *Gloeothece* Naegeli	
(1) *G. palea* (Kuetz.) Rabenherst.	On dripping rocks.
(2) *G. rupestris* (Lyngbye) Bornet.	On dripping rocks.
Family Nostochopsidaceae.	
4. Genus *Nostochopsis*	
N. lobatus Wood emend. Geitler.	On dripping rocks.
Family Microchaetaceae	
5. Genus *Aulosira* Kirchner	
(1) *A. impexa* Born. et Flah. v. *crassa* Dixit.	On dripping rocks.
6. Genus *Fortiea* De Toni	
(1) *F. bossei* (Fremy) Desikachary v. *indica* Kamat.	On dripping water.
Family Rivulariaceae	
7. Genus *Calothrix* Agardh.	
C. fusca (Kuetz.) Born. et Flah.	Embedded in *Nostoc* colonies.
8. Genus *Dichothrix*	
(1) *D. baueriana* (Grun.) Born. et Flah.	In dripping water.

Name	Habitat and Locality
9. Genus *Rivularia* (Roth) Agardh.	
R. dura Roth ex Born.. et Flah.	On dripping rocks.
Family Scytonemataceae	
10. Genus *Tolypothrix* Kuetzing	
(1) *T. byssoidea* (Hassell) Kirchner.	On dripping rocks.
(2) *T. rupestris* Wolle ..	On dripping rocks.
11. Genus *Scytonema* Agardh	
(1) *S. myochrous* (Dilw.) Agardh.	On dripping rocks.
Family Nostocaceae	
12. Genus *Anabaena* Bory	
A. torulesa (Carm). ..	On dripping rocks.
13. Genus *Cylindrospermum* Kuetzing	
(1) *C. muscicola* Kuetz. ex Born. et Flah.	On dripping rocks.
(2) *C. stagnale* (Kuetz.) Born et Flah.	
14. Genus *Nostoc* Vaucher	
(1) *N. commune* Vaucher ex Born., et Flah.	On dripping rocks.
(2) *N. microscopicum* Carm. ex Born. et Flah.	On dripping rocks.
(3) *N. muscorum* Agardh ex Born. et Flah.	On dripping rocks.
(4) *N. piscinale* Kuetzing ex Born. et Flah.	On dripping rocks.
Family Oscillatoriaceae	
15. Genus *Oscillatoria* Vaucher	
(1) *O. crosdalei* Kamat ..	In a pond (15-10-1957).
(2) *O. jasorvensis* Vouk ..	On dripping rocks.
(3) *O. mahabaleshwarensis* Kamat.	On dripping rocks.
16. Genus *Phormidum* Kuetzing	
P. rividum Naegeli	
17. Genus *Lyngbya* Agardh	
(1) *L. allorgei* Fermy v. *granulata* Kamat.	
(2) *L. lutea* (Agardh) Gomont.	On moist soil along with.
18. Genus *Schizothrix* Kuetzing	
S. fragilis (Kuetz.) Gomont	

Name	Habitat and Locality
CHLOROPHYTA	
Family Tetrasporaceae	
1. Genus *Tetraspora* Link	
T. gelatinosa (Vaucher) Desvaux. ..	In Dina lake.
Family Cladophoraceae	
2. Genus *Cladophora* Kuetzing	
C. callicoma Kuetz.	On stones in a pond.
3. Genus *Rhizoclonium* Kuetzing.	
R. hieroglyphicum (Agardh) Kuetzing.	Floating at the shores in Venna lake (Mahabaleshwar).
Family Coelastraceae	
4. Genus *Coelastrum* Naegeli	
C. microsporum Naegeli ..	Floating along with other algae in Venna lake.
5. Genus *Pediastrum*	
P. tetras (Ehren.) Ralfs. ..	Floating along with other algae in Venna lake.
Family Oocystaceae	
6. Genus *Ankistrodesmus*	
A. falcatus (Corda)	Floating along with other algae in Venna lake.
Family Scenedesmaceae	
7. Genus *Scenedesmus*	
S. mahableshwarensis Kamat	In a pond, Mahabaleshwar (16-10-57).
Family Zygnemataceae	
8. Genus *Zygnema*	
Zygnema extenue Jao ..	Floating in Venna lake.
9. Genus *Spirogyra*	
S. fossa Jao	Floating in Venna lake.
S. mirabilis (Hassall) Kuetz. *maharashtrensis* Kamat.	In Venna lake (16-10-57).
Family Mesotaeniaceae	
10. Genus *Mesotaenium*	
M. mirificum Arch. v. *mahabaleshwarensis* Kamat.	In humid axes of trees (17-10-57).
Family Desmidiaceae	
11. Genus *Closterium*	
C. macilentum Brebisson	In a discarded well along the Babington point.

Name	Habitat and Locality
C. undulatum Corda *v. crenulatum* (Naegeli) Wittrock.	On dripping rocks.
G. undulatum Corda v. *wollei* West.	Floating along with other algae in Venna lake.
12. Genus *Micrasterias*	
M. denticulata Brebission	Floating along with other algae in Venna lake.
13. Genus *Staurastrum*	
1. *S. setigerum* Cleve ..	Floating with other algae in Venna lake.
14. Genus *Hyalotheca*	
H. burmensis W. and G. S. West.	Floating with other algae in Venna lake.
H. mucosa (Mert.) .. Ehrenberg.	Floating along with other algae in Venna lake.
15. Genus *Spondylosium*	
S. lundellii Borge.	Floating along with other algae in Venna lake.

18. ALGAE OF MARATHWADA

We shall now consider the Algae of Marathwada region. There is only one paper dealing with them by N. D. Kamat (1974) in *Phykos* 3 (1) : 22—32. It gives account of 151 Algae collected at Aurangabad, Parli, Beed, Jalna, Osmanabad, Parbhani and Nanded. The species belong to Chlorophyceae, Euglenophyceae, Dinophyceae, Xanthophyceae and Cyanophyceae. Of these 65 species belong to Chlorophyceae, 27 belong to Euglenophyceae, 3 to Dinophyceae, 1 to Xanthophyceae and 54 to Cyanophyceae.

The region is full of a number of ponds and seasonal water streams running zig-zag. They contain many algae. The largest number is constituted by species of *Spirogyra, Zygnema, Mouqueotia, Oedogonium Bulbochaete, Nostoc, Cylindrospermum* and *Anaebaena.* Since all the habitats have not been checked, it is likely that many more species and forms would be found. So far the richest growth of Algae was noted in a pond at Osmanabad.

CHLOROPHYTA

Name	Habitat and Locality
1 *Pandorina morum* (Muell.) Bory.	Mundlika stream, Jalna. Pond, Osmanabad.
2 *Gloeocystis vesiculosa* .. Naegeli.	Pond, Osmanabad.
3 *Tetraspora lubrica* (Roth) .. Agardh.	Bindusara dam, Parli. Puddle, Aurangabad.

	Name	Habitat and Locality
4	*Pediastrum duplex* Meyen v. *reticulatum* Lagarh ..	Hansool lake, Parbhani. Pools, Aurangabad. Pools, Nanded. Pools, Beed.
5	*P. duplex* Meyen .. .. v. *subgranulatum* Racib.	Ponds, Osmanabad. Streamlet, Aurangabad.
6	*P. simplex* Meyen	Moti Talao, Jalna. Streamlet, Aurangabad. Ponds, Nanded.
7	*P. simplex* Meyen V. *duodenarium* (Baily) Rabenh.	Harsool lake, Aurangabad. Moti Talao, Jalna.
8	*P. tetras* (Ehr.) Ralfs v. *tetradon* (Corda) Rabenh.	Ponds, Osmanabad. Puddle, Parbhani. Ponds, Nanded. Pools, Aurangabad.
9	*Sorastrum americanum* .. (Bohlin) Schmidle.	Ponds, Osmanabad.
10	*Coelastrum microporum* .. Naegeli.	Kundalika stream, Jalna. Harsool lake, Aurangabad. Puddles, Nanded.
11	*C. scabrum* Roinsch	Harsool lake, Aurangabad. Bindusara dam, Pali.
12	*Dictyosphaerium pulchellum* .. Wool.	Harsool lake, Aurangabad.
13	*Oocystis gigas* Archer ..	Ponds, Osmanabad.
14	*O. macrospora* (Turp.) .. Brunnthaler.	Puddles, Aurangabad.
15	*O. lacustris* Chodat	Stream, Beed.
16	*O. naegelii* A. Br.	Ponds, Osmanabad. Pools, Parbhani. Pools, Beed.
17	*O. solitaria* Wittrock ..	Moti Talao, Jalna. Ponds, Osmanabad. Pools, Aurangabad.
18	*Nephrocytium agardhianum* .. Naeg.	Moti Talao, Jalna. Ponds, Nanded. Bhogavati stream, Osmanabad.
19	*Chodatella subsalsa* Lamm. ..	Harsool lake, Aurangabad.
20	*Ankistrodesmus falcatus* (Corda) Ralfs.	Ponds, Osmanabad. Stream, Jalna. Cistern, Aurangabad.
21	*A. sigmoides* (Rabenh.) .. Bruhl. et Biswas.	Stream, Jalna.
22	*Schroederia indica* Phillipose	Ponds, Osmanabad.
23	*Selenastrum gracile* Reinsch	Ponds, Osmanabad.
24	*Tetraedron incus* (Teiling) G. M. Smith.	Moti Talao, Jalna.
25	*S. minimum* (A. Br.) Hansg.	Stream/Ponds, Osmanabad. Pools, Parli.

	Name	Habitat and Locality
26	*Scenedesmus abundans* (Kirchn.) Chodat. v. *brevicauda* G. M. Smith. ..	Moti Talao, Jalna.
27	*S. acuminatus* (Lagerh.) Chodat. ..	Moti Talao, Jalna.
28	*S. arcuatus* (Lemm.) Lemm.	Stream, Jalna. Puddles, Nanded. Pools, Pali. Stream, Beed. Harsool lake, Aurangabad.
29	*S. bijugatus* (Turp.) Kuetz.	Harsool lake, Aurangabad. Puddles, Parbhani.
30	*S. denticulatus* Lagerh. v. *australis* Playf.	Ponds, Jalna. Pools, Aurangabad.
31	*S. hystrix* Lagarh.	Ponds, Osmanabad. Pools, Nanded.
32	*S. longus Meyen* v. *brevispina* G. M. Smith.	Moti Talao, Jalna.
33	*S. obligus* (Turp.) Kuetz. ..	Stream, Jalna. Bindusara Dam, Pali.
34	*S. opoliensis* P. Richter ..	Stream, Jalna.
35	*S. quadricauda* (Turp.) Breb. v. *quadrispina* (Chodat).	Ponds, Osmanabad. Cisterns, Aurangabad.
36	*S. quadricauda* (Turp.) Breb. v. *mestii* G. M. Smith.	Pools, Pali.
37	*Ulothrix aequalis* Kuetzing	Stream, Osmanabad.
38	*U. cylidriqum* Prescott ..	Bindusara Dam, Pali.
39	*U. subtilissima* Rabenh. ..	Moti Talao, Jalna.
40	*U. tenerrima* (Kuetz.) Kuetz.	Pools, Pali. Stream, Osmanabad.
41	*U. variabilis* (Kuetz.) Kuetz.	Stream, Osmanabad.
42	*Stigeoclonium lubrigum* (Dillw.) ..	Stream, Jalna.
43	*S. nanum* Kuetz	Harsool lake, Aurangabad.
44	*S. tenue* (Ag.) Kuetz. ..	Stream, Osmanabad.
45	*Aphanochaete polychaete* (Hansigirg) Fritsch. ..	Ponds, Osmanabad.
46	*Coleochaete orbicularis* Pringsheim. ..	Ponds, Osmanabad.
47	*Protococcus viridis* Agardh ..	Walls, Aurangabad, Nanded, Parbhani.
48	*Rhizoclonium hieroglyphicum* (Ag.) Kuetz.	Streamlet, Aurangabad. Ponds, Nanded; Osmanabad, Parbhani.
49	*Oedogonium echinospirale* Lacerda.	Ponds, Osmanabad.
50	*O. plagiostomum* Wittr. ex. Hirn. V. *gracilius* Wittr. ex. Hirn.	Ponds and Streams, Pali.

	Name	Habitat and Locality
51	*O. plusiosporum* Wittr. ex Hirn.	Stream, Jalna.
52	*O. poecilosporum* Nordst. ex Hirn. V. *minor* Kamat.	Lake, Aurangabad.
53	*O. spurium* Hirn.	Lake, Aurangabad.
54	*O. suecicum* Wittr. ex Hirn.	Ponds, Osmanabad.
55	*O. tapeinosporum* Wittr. ex	Puddles, Aurangabad.
56	*Spirogyra condensata* (Vouch) Kuetz.	Puddles, Aurangabad. Stream, Beed.
57	*S. fragilis* Jao	Puddles, Aurangabad.
58	*S. gracilis* (Hassall) Kuetz.	Moti Talao, Jalna.
59	*S. hyalina* Cleve	Stream, Beed.
60	*S. irregularis* Naegeli ..	Stream, Jalna.
61	*S. macrospora* (Rao) Krieger	Stream, Jalna. Ponds, Osmanabad. Pools, Nanded.
62	*Zygnema guadrangulatum* Jao	Ponds, Osmanabad.
63	*Zygnemopsis sarvatiensis* .. Iyengar.	Puddles, Aurangabad.

EUGLENOPHYCEAE :

	Name	Habitat and Locality
64	*Euglena acus* Ehrenberg ..	Moti Talao, Jalna.
65	*E. charkcwiensis* Swir ..	Ponds, Osmanabad. Pools, Nanded.
66	*E. heimii* Lefevre	Ponds, Osmanabad.
67	*E. proxima* Dang	Lake, Aurangabad.
68	*E. sanquinea* Ehr.	Bindusara Dam, Pali.
69	*E. spirogyra* Ehr. v. *supreme* skuja.	Ponds, Osmanabad.
70	*Phacus acuminatus* Stokes ..	Ponds, Osmanabad.
71	*P. platalea* Drez.	Puddle, Osmanabad.
72	*P. undulatus* (Skv.) Pochm.	Pools, Osmanabad. Stream, Pali.
73	*Trachelomonas allia* Drez. emend. Defl.	Stream, Pali.
74	*T. armata* (E) Stein. v. *sparsigranosa* Playf.	Stream, Pali.
75	*T. armata* (E). Stein. V. .. Steinii Lamm. emend Defl.	Ponds, Osmanabad.
76	*T. bacillifera* Playf. v. *ovalis* Playf.	Ponds, Osmanabad. Pools, Nanded.
77	*T. conica* Playf.	Ponds, Osmanabad.
78	*T. granulosa* Playf	Stream, Pali.
79	*T. hispida* (Party) Stein. emend Defl.	Lake, Aurangabad. Ponds, Osmanabad. Pools, Nanded. Puddles, Parbhani.

	Name	Habitat and Locality
80	*T. hispida* (Partim)) Stein emend Defl. v. *punctata* Lamm.	Moti Talao, Jalna.
81	*T. nigra* Swir	Stream, Beed.
82	*T. oblonga* Lemm. v. *truncata* Lamm.	Ponds, Osmanabad.
83	*T. oviformis* Drez.	Moti Talao, Jalna.
84	*T. scabratula* (Playf.) Dafl ..	Lake, Aurangabad.
85	*T. sydneyensis* Playf	Ponds, Osmanabad. Stream, Pali.
86	*T. sydneyensis* Playf. v. *minima* Playf.	Ponds, Osmanabad.
87	*T. varians* Defl.	Moti Talao, Jalna.
	T. volvocina Ehrenberg ..	Pools, Pali. Ponds, Osmanabad. Moti Talao, Jalna. Pools, Nanded. Ponds, Parbhani. Lake, Pools, } Aurangabad.
88	*Menoidium pellusidum* Perty	Ponds, Osmanabad.

DINOPHYCEAE

89	*Gymnodinium albulum* Lindem	Pools, Pali.
90	*G. rotundatum* Klebs ..	Lake, Aurangabad.
91	*G. tartricum* Wol.	Moti Talao, Jalna. Pools, Pali.

XANTHOPHYCEAE

92	*Botrydium granulatum* (L.) Greville.	Pools, Beed. Puddles, Pali. Puddles, Nanded, Aurangabad, Parbhani, Osmanabad.

CYANOPHYCEAE

93	*Microcystis aeruginosa* Kuetz	Ponds, Pali.
94	*Aphanothece castegnei* (Breb.) Rabenh.	Stream, Jalna. Pools, Pali.
95	*A. microscopica* Naeg. ..	Stream, Pali.
96	*A. naegelii* Wartm.	Ponds, Osmanabad.
97	*A. pallida* (Kuetz.) Rabenh.	Moist soils, Osmanabad, Nanded, Aurangabad, Parbhani.
98	*Chroococcus minutus* (Kuetz.) Naeg.	Puddle, Aurangabad. Pools, Beed.
99	*C. turgidus* (Kuetz.) Naeg. ..	Cisterns, Aurangabad, Moist soils, Aurangabad.
100	*C. turicensis* (Naeg.) Hansg.	Moti Talao, Jalna.
101	*Gloeothece geoppertiana* (Hilse) Forti. ..	Cisterns, Aurangabad.

Name	Habitat and Locality
102 *Merismopedia elegans* A. Br.	Moti Talao, Jalna.
103 *M. glauca* (Ehrenb.) Naeg.	Stream, Beed. Pools, Pali. Stream, Aurangabad. Ponds, Osmanabad. Moti Talao, Jalna.
104 *M. punctata* Meyen	Moti Talao, Jalna. Pools, Beed. Streamlet, Aurangabad.
105 *Synechocystis aquatilis* Sauv.	Moti Talao, Jalna.
106 *Myxocarcina spectabilis* .. Geitler.	Puddle, Aurangabad.
107 *Spirulina major* Kuetz. ex Gomont.	Ditches, Jalna.
108 *S. nordstedtii* Gom.	Moti Talao, Jalna.
109 *Arthospira balkrishnanii* .. Kamat.	Moti Talao, Jalna.
110 *Oscillatoria amphigranulata* Van. Goor f. *conica* Kamat.	Ponds, Osmanabad.
111 *O. boryana* Bory ex Gomont	Dam wall, Pali. Pools, Jalna. Stream, Osmanabad. Gutters, Aurangabad.
112 *O. formosa* Bory ex Gomont	Gutters, Aurangabad. Gutters, Osmanabad.
113 *O. jenensis* G. Schmid ..	Streamlets, Aurangabad.
114 *O. mougeotii* Kuetz.	Dirty walls, Aurangabad, Nanded, Beed, Osmanabad, Parbhani.
115 *O. okeni* Ag. ex Gomont ..	Gutters, Aurangabad, Pali, Nanded, Beed, Osmanabad, Jalna, Parbhani.
116 *O. okeni* Ag. ex Gom. V. *gracilis* Kuetz. ex Gom.	Moti Talao, Jalna.
117 *O. princepe* Vauch. ex Gom.	Moti, Talao, Jalna, Ponds/stream, Osmanabad, Aurangabad. Pools, Pali.
118 *O. pseudogeminata* G. Schmid f. *longa* Kamat.	Stream, Osmanabad.
119 *O. quadripunctulata* Bruhl. et Nosw as v. *unigranulata* R. N. Singh f. *ahmedabadensis* Kamat.	Moti Talao, Jalna. Dam, Pali.
120 *O rubescens* D. C. ex. Gomont v. *curvata* Kamat.	Moti Talao, Jalna.
121 *O. rubescens* D. C. ex. Gomont v. *kolhapurensis* Kamat.	Dam wall, Osmanabad.
122 *O. tambi* Woronich	Ponds, Osmanabad.
123 *O. ulrichii* Prat	Moti Talao, Jalna. Lakes, Aurangabad.

	Name	Habitat and Locality
124	*Phormidium anomala* C. B. Rao.	Pools, Beed. Moti Talao, Jalna.
125	*P. autumnale* (Ag.) Gom. ..	Moist soils, Nanded. Moist soils, Osmanabad.
126	*P. frigidum* Fritsch	Stagnant water, Jalna. Stream Pools, Beed.
127	*P. pristelei* F. E. Fritsch ..	Walls, Osmanabad. Puddle, Nanded.
128	*P. uncinnatum* Gom. ..	Pools, Beed. Moist soil, Aurangabad.
129	*Lyngbya hirgei* G. M. Smith	Moti Talao , Jalna.
130	*L. shackletoni* W. et. G. S. West.	Pools, Streams, Pali.
131	*L. gandhii* Kamat	Lake, Aurangabad.
132	*L. infixa* Fremy	Cistern, Aurangabad.
133	*Microcoleus chthonoplastes* Thuret ex Gomont.	Moist soils, Aurangabad, Nanded, Beed, Parbhani.
134	*Schizothrix rubella* Gom. ..	Moist soils, Beed.
135	*Calothrix fusca* (Kuetz.) Born. et Flah.	Ponds, Osmanabad.
136	*C. karnatakensis* Gonzalves et Kamat V. *major* Gonzalves et Kamat.	Ponds, Osmanabad.
137	*C. marchica* Lamm.	Puddle, Beed.
138	*Dichothrix willei* Gardner ..	Cisterns, Aurangabad, Nanded.
139	*Gloeotrichia pilgeri* Schmidle	Ponds, Osmanabad.
140	*G. raciborskii* Wolosz ..	Ponds, Osmanabad.
141	*Microchaeta uberrima* Carter	Ponds, Osmanabad.
142	*Aulosira fertilissima* Ghose v. *tenuis* C. B. Rao.	Puddle, Beed.
143	*Nostoc piscipale* Kuetz. ex Born. et Flah.	Ponds, Osmanabad.
144	*Anabaena volzii* Lamm. ..	Pools, Stream, Beed.
145	*Scytonema mirabile* (Dillw.) Born.	Puddle, Beed.

19. ALGAE OF VIDARBHA

(After N. D. Kamat, 1975, J. B. N. H. S., **72** : 450-476)

CHLOROPHYCEAE

Name	Locality
Chlamydomonas globosa Snow ..	Amravati, Katol.
C. snowii Printz.	Akola.
Gonium pectorale Muell	Amravati, Bhandara, Tiroda.
Eudorina elegans Ehrenberg ..	Bhandara.
Sphaerocystis schroestri Chodat ..	Bhandara, Tumsar, Tiroda.

Name	Locality
Gloeocystis ampla (Kuetz.) Lagarh.	Umred.
G. gigas (Kuetz.), Lagerh	Amravati.
Tetraspora gelatinosa (Vauch.) Desvaux.	Yeotmal.
T. lacustris Lemm.	Bhandara.
Elakatothrix viridis (Snow) Printz ..	Amravati, Khamgaon, Akola, Bhandara.
Micractinium pusillum Fresen ..	Bhandara.
Dictyosphaerium pulchellum Wood	Bhandara.
Dimorphococcus lunatus A. Br. ..	Umred, Bhandara.
Schroedria indica Philipose	Amravati.
S. robusta Korsh	Wardha.
S. setigera (Schroeder) Lemm. ..	Amravati.
Korshikoviella gracilipes (Lamb.) Silva.	Amravati.
Pediastrum boryanum (Turpin) Meneghini.	Dahegaon, Amravati, Tiroda.
P. duplex Meyen	Mansar, Yeotmal, Bhandara.
P. duplex Meyen v. *clathratum* (A. Br.) Lagerh.	Bhandara.
P. duplex Meyen v. *cohaerens* Bohlin	Mansar, Tumsar, Bhandara, Tiroda.
P. duplex Meyen v. *gracilimum* West et West.	Bhandara.
P. integrum Naeg. v. *perforatum* Racib.	Tiroda.
P. muticum Kuetz.	Mansar.
P. simplex Meyen	Amravati, Bhandara.
P. simplex Meyen v. *duodenarium* (Baily) Rabenh.	Amravati, Bhandara.
P. tetras (Ehrenb.) Ralfs.	Umred, Mansar, Amravati.
P. tetras (Ehrenb.) Ralfs. .. .. v. *tetraedron* (Corda) Hansg.	Pavanar.
Sorastrum americanum (Bohlin) Schmidle.	Mansar, Tumsar, Bhandara.
S. americanum (Bohlin) Schmidle v. *undulatum* Smith.	Amravati.
S. spinulosum Naeg	Amravati, Tumsar, Bhandara.
Coelastrum cambricum Arch. v. *intermedium* (Bohlin) G. S. West.	Amravati, Umred, Tumsar, Bhandara, Tiroda.
C. microporum Naeg.	Tumsar, Tiroda.
C. reticulatum (Dang.) Senn. ..	Bhandara.
Westella botryoides (W. West) De Wild.	Bhandara.
Nephrocytium hydrophilum (Turn.) Wille.	Amravati.
N. obseum West et West	Amravati.

Name	Locality
Trochiscia reticulatis (Reinsch) Hansg. ..	Mansar.
Oocystis borgei Snow	Chandrapur, Tumsar, Bhandara, Tiroda.
O. elliptica W. West	Umred, Amravati.
O. gigas Arch.	Amravati.
O. macrospora (Turn.) Brunnth ..	Mansar.
O. pusilla Hansg.	Tumsar, Bhandara.
O. solitaria Wittr. v. *major* Wille ..	Mansar.
Gloeotaenium leitsbergianum Hansg.	Amravati, Bhandara.
Ankistrodesmus convolutuz Corda ..	Bhandara.
A. falcatus (Corda) Ralfs.	Umred, Mansar, Amravati, Tiroda.
A. falcatus (Corda) Ralfs. v. *mirabilis* (West et West) G. S. West.	Amravati.
A. falcatus (Corda) Ralfs v. *tumidus*	Amravati.
A. spiralis (Turn.) Lemm.	Umred, Bhandara.
Selenastrum bibraianum Reinsch ..	Umred.
Kirchneriella lunaris (Kirchn.) Moebius.	Bhandara.
K. lunaris (Kirchn.) Moebius v. *irregularis* G. M. Smith.	Umred.
K. subsolitaria G. S. West	Bhandara.
Tetraedron hastatum (Reinsch) Hansg.	Amravati.
T. minimum (A. Br.) Hansg. ..	Amravati.
T. pentaedricum West et West ..	Bhandara.
T. pusillum (Wall.) West et West ..	Bhandara.
T. trigonum (Naeg.) Hansg	Amravati, Bhandara.
Scenedesmus arcuatus Lemm. v. *platydisca* G. M. Smith.	Umred, Bhandara.
S. bijuga (Turp.) Lágerh	Bhandara.
S. bijuga (Turp.) Lagerh. v. *alternans* (Reinsch) Hansg.	Tumsar, Bhandara.
S. bijuga (Turp.) Lagerh. v. *alternans* (Reinsch) Hansg. f. *parvus* G. M. Smith.	Wardha, Chandrapur.
S. denticulatus Lagerh.	Bhandara.
S. denticulatus Legerh. v. *australis* Play f.	Bhandara.
S. dimorphus (Turp.) Kuetz. ..	Chandrapur, Amravati, Tumsar, Bhandara.
S. hystrix Lagerh	Bhandara.
S. longus Meyen	Umred.
S. longus Meyen v. *minutum* G. M. Smith.	Bhandara.

Name	Locality
S. obliguus (Turp.) Kuetz.	Tumsar, Bhandara.
S. quadricauda (Turp.) De Breb. v. *longispina* (Chodat) G. M. Smith.	Chandrapur.
S. quadricauda (Turp.) De Breb. v. *maximus* West et West.	Wardha, Tumsar, Bhandara.
Crucigenia rectangularis (Naeg.) Gay	Amravati.
Tetrallantos lagerheimii Tailing ..	Umred.
U. lothrix aequalis Kuetz.	Umred.
U. cylindricum Prescott	Wardha.
U. subconstricta G. S. West ..	Umred.
U. tenerrima (Kuetz.) Kuetz. ..	Umred, Amravati, Tumsar.
Cylindrocapsa oedogonioides Randhawa. ..	Mansar.
Stigeoclonium attenuatum (Hazen) Collins	Umred.
S. hubneri Heering	Tumsar.
S. lubricum (Dillw.). Kuetz..	Amravati.
S. nanum Kuetz.	Umred.
Chaetophora pisciformis (Roth) Agardh.	Mansar.
Coleochaete irregularis Pringsheim	Tumsar.
C. orbicularia Pringsheim	Mansar, Amravati, Tumsar.
C. scutata De Breb.	Tumsar, Tiroda.
C. soluta (De Breb.) Pringsheim ..	Tiroda.
Protococcus viridis C. A. Agardh ..	Amravati.
Fritschiella tuberosa Iyengar ..	Sakoli.
Chaetosphaeridium globosum (Nordst.) Klebahn. ..	Tiroda.
C. pringsheimii Klebahn f. *conferta* Kelbahn.	Tumsar.
Gomontia holdenii Collins ..	Umred.
Rhizoclonium hieroglyphicum (C. A. Ag.) Kuetz.	Amravati, Bhandara.
Pithophora oedogonia (Mont.) Wittr.	Amravati, Dahegaon, Katol, Khamgaon, Gondia, Sakoli, Wardha, Tiroda.
Cladophora glomerata (L.) Kuetz. ..	Amravati, Lonar, Sakoli, Yeotmal.
Oedogonium aster Wittr. ex Hirn ..	Amravati.
O. australianum Hirn	Mansar.
O. autumnale Wittr. ex Hirn ..	Umred.
O. clavam Wittr. ex Hirn	Tiroda.
O. cardiacum (Hans.) wittr. ex Hirn. f. *interjectum* Hirn.	Bhandara.
O. crispum (Hans.) Wittr. ex Hirn..	Umred.

Name	Locality
O. elegans West et West v. *americanum* Jao.	Tiroda.
O. ellipsoideum Jao	Mansar.
O. flexuosum Hirn	Yeotmal.
O. inconspicum Hirn	Mansar.
O. inframediale Jao	Mansar.
O. obesum (Wittr.) Hirn	Bhandara.
O. obtruncatum wittr. ex Hirn v. *ellipsoideum* wittr. ex Hirn	Bhandara.
O. inframediala Jao	Mansar.
O. obesum (Wittr.) Hirn	Bhandara.
O. obtruncatum Wittr. ex Hirn v. *ellipsodeum* Wittr. ex Hirn	Bhandara.
O. plagiostomum Wittr. ex Hirn v. *gracilis* wittr. ex Hirn	Bhandara.
O. poecilosporum Nord. et Hirn ..	Tiroda.
O. porrectum Nordst. ex Hirn ..	Mansar.
O. pringsheimii Cramer. Wittr. ex Hirn v. *nordstedtii* wittr. ex Hirn	Bhandara.
O. pseudospirale Nygaard	Bhandara.
O. pusillum Kirchn. ex Hirn ..	Amravati.
O. santurcense Tiff.	Bhandara.
O. subaerolatum Jao	Amravati.
O. tapeinosporum wittr. ex Hirn ..	Amravati, Tiroda.
O. undulatum (Breb.) Al. Braun: Wittr. ex Hirn	Amravati, Bhandara, Wardha.
O. urbicum Wittr. ex Hirn	Bhandara.
O. virceburgense Hirn	Amravati, Tiroda.
Bulbochaete diamesandria Nordstedt ex Hirn	Tiroda.
B. lagoensis Wittr. ex. Hirn ..	Tiroda.
B. variana wittr. ex Hirn	Amravati.
Netrium digitus (Ehrenb.) Itzig. et Roth v. *lamellosum* (Breb.) Gronbl.	Tiroda.
Cylindrocystis americana West et west v. *minor* Cushm.	Mansar.
Gonatozygon aculeatum Hast. ..	Mansar.
G. kinahani (Arch.) Rabenh. ..	Mansar.
G. monotaenium De Bary	Umred, Tumsar, Sakoli, Bhandara, Tiroda.
G. pilosum Wille	Mansar.
Pleurotaenium baculoides (Roy et Biss.) Playf.	Mansar, Tiroda.

Name	Locality
P. ehrenberdii (Breb.) De Bary ..	Tumsar.
P. elatum (Turner) Borge v. *sub-undulatum* Hirano.	Satnavri.
P. indicum (Grun.) Lund	Bhandara, Tumsar.
P. incrmium (Moeb.) Hirano ..	Umred, Chandrapur, Bhandara.
P. simplicissimum Gronbl ..	Tumsar.
P. simplicissimum Gronbl. v. *semi-undulatum* Hirano.	Umred, Chandrapur, Tumsar.
P. ovatum Nordst	Chandrapur, Bhandara, Mansar.
P. subcoronulatum (Turn.) West et West.	Mansar.
P. trabecula (Ehrenb.) Naeg ..	Amravati, Umred.
P. trabecula (Ehrenb.) Naeg. v. *maximum* (Reinsch) Roll. f. *constrictum* Scott et Prescott.	Bhandara.
P. trabecula (Ehrenb.) Naeg. f. *clavata* (Kuetz) West et West.	Mansar.
P. trabecula (Ehrenb.) Naeg. v. *rectum* (Delp.) West et West.	Umred, Amravati, Tiroda.
Closterium acerosum (Schrank) Ehrenberg.	Umred.
C. acerosum (Schrank) Ehrenb. f. *rectum* Scott et Prescott.	Chandrapur.
C. aciculare West et West	Amravati.
C. acutum Breb	Umred, Bhandara.
C. acutum Breb. v. *variable* (Lemm.) Krieger.	Satnavri, Sakoli
C. calosporum Wittr.	Wardha.
C. calosporum Wittr. v. *brasiliense* Borg.	Umred.
C. cornu Ehrenb.	Satnavri, Yavatmal, Umred.
C. cornu Ehrenb. v. *upsaliense* Nordst.	Umred.
C. cynthia De Not	Umred, Tiroda.
C. dianae Ehrenb.	Umred, Amravati, Bhandara.
C. ehrenbergii Menengh.	Umred.
C. gracile Breb.	Amravati, Chandrapur.
C. idiosporum West et West ..	Yeotmal.
C. incurvum Breb.	Amravati, Sakoli, Tumsar.
C. jenneri Ralfs v. *tenue* Croasdale	Umred, Bhandara.
C. kuetzingii Breb.	Umred.
C. lanceolatum Kuetz.	Satnavri, Amravati.
C. leibleinii Kuetz.	Mansar.
C. libellula Focke	Tiroda.
C. lineatum Ehrenb.	Mansar.
C. littorale Gay	Umred, Tumsar, Bhandara.

Name	Locality
C. macilentum Breb.	Tumsar, Sakoli.
C. parvulum Naeg.	Satnavri, Umred, Chandrapur, Tumsar.
C. setaceum Ehrenb.	Umred.
C. sinense Lutkem.	Satnavri, Tumsar.
C. tumidulum Gay	Amravati, Yeotmal.
C. tumidum Johnson	Mansar.
C. venus Kuetz.	Mansar.
C. venus Kuetz. v. *incurvum* (Breb.) Krieger.	Amravati.
Cosmarium abbreviatum Racib. ..	Bhandara.
C. abbreviatum Racib. f. *pygmaea* Messik.	Amravati.
C. amoenum Breb.	Umred, Bhandara.
C. auriculatum Reinsch	Satnavri, Amravati, Chandrapur, Bhandara.
C. bengalense (Grun.) Turn. ..	Umred, Tumsar, Bhandara.
C. biloculatum Breb. v. *subpunctulatum* Krienger et Gerloff.	Umred.
C. botrytis Menegh.	Amravati.
C. zeylanicum West et West f. *minus* Scott et Prescott.	Mansar.
C. connatum Breb.	Amravati.
C. contractum Kirchn.	Umred.
C. contractum Kirchn. f. *jacobsenii* (Roy) West et West.	Amravati, Mansar.
C. contractum Kirchn. v. *ellipsoideum* (Elfv.) West et West.	Mansar.
C. contractum Kirchn v. *minutum* (Delp.) West et West.	Mansar.
C. contractum Kirchn. v. *norvegicum* Racib.	Jawahar Nagar.
C. cucurbitinium (Biss.) Lutkem ..	Mansar, Tiroda.
C. cucurbitinum (Biss.) Lutkem v. *grande* Gronbl.	Amravati.
C. depressum (Naeg.) Lund. v. *intermedium* (Gutw.) Messik.	Akola.
C. difficile Lutken v. *dilatum* Borge.	Mansar.
C. dispersum Johnson	Bhandara.
C. dubicum Borge	Amravati, Tiroda.
C. dybowakii Gutw.	Bhandara.
C. elegantissimum Lund. f. *minor* West.	Mansar.
C. exiguum Arch.	Umred.
C. freemanii West et West	Umred.
C. furcatospermum West et West v. *koreana* Skv.	Amravati.

Name	Locality
C. fusceense Hirano	Mansar, Akola.
C. garrolense Roy et Bias. v. *crassum* Jao.	Amravati.
C. granatum Breb	Amravati.
C. hammeri Reinsch v. *homalodermum* (Nordat.) West et West.	Bhandara.
C. hammeri Reinsch v. *protuberans* West et West.	Amravati.
C. impressulum Elfv.	Amravati, Tumsar.
C. impressulum Elfv. v. *octangularis* Hirano.	Tiroda.
C. inconspicuum Arch.	Amravati.
C. infirmum Gronbl. v. *minus* (Gronbl.) Krieger et Garloff.	Jawahar Nagar.
C. laeve Rabenh	Amravati, Umred.
C. laeve Rabenh. v. *depressum* Croasdale.	Amravati, Tumsar.
C. lagenarioides (Roy) Lutk. ..	Bhandara.
C. lunatum Wolle v. *sparsum* (Turn.) Krieger et Garloff.	Mansar.
C. lundelli Delp. v. *circulare* (Reinsch) Krieger.	Amravati, Akola.
C. lundelli Delp. v. *corruptum* (Turn.) West et West.	Tiroda.
C. lundelli Delp. v. *ellipticum* West	Mansar, Bhandara, Tiroda.
C. maculatum Turn	Umred, Tumsar.
C. mansangense West et West ..	Tumsar.
C. margaritatum (Lund) Roy et Bisset.	Akola, Jawahar Nagar.
C. margaritatum (Lund) Roy et Bisset f. *minor* (Boldt) West et West.	Umred, Jawahar Nagar, Bhandara.
C. moniliforme (Turp.) Ralfs v. *panduriforme* (Heimerl) Schmidle.	Bhandara.
C. nymannianum Grun.	Dahegaon.
C. nymannianum Grun. v. *brevis* (Wille) Krieger et Gerloff.	Umred.
C. obsoletum (Hantzsch) Reinsch v. *sitvense* Gutw.	Umred.
C. obtusatum Schmidle	Pavnar, Mansar, Tumsar, Bhandara.
C. orthostichum Lund	Yeotmal.
C. orthostichum Lund. f. *subpolonica* Messik.	Yeotmal.
C. phaseolus Breb. v. *achondrum* Boldt.	Tumsar.
C. polonicum Racib	Tumsar.

Name	Locality
C. polygonum (Naeg.) Arch ..	Mansar.
C. portianum Arch.	Akola, Tiroda.
C. portianum Arch. v. *nephroideum* Wittr.	Amravati.
C. pseudadoxum Jao	Amravati.
C. pseudoconnatum Nordst. ..	Tiroda.
C. pseudohexagonoides Bruhl et. Biswas.	Amravati.
C. pseudopyramidatum Lund ..	Tiroda.
C. pseudopyramidatum Lund v. *borgei* Krieger et Gerloff. ..	Bhandara, Tumsar.
C. pseudopyramidatum Lund. v. *carniolicum* Lutk.	Tumsar, Jawahar Nagar.
C. pseudopyramidatum Lund. v. *rotundatum* Krieger et Gerloff.	Tumsar.
C. pyramidatum Breb.	Amravati.
C. pyramidatum Breb. v. *convexum* Krieger et Gerloff.	Amravati.
C. quardratulum (Gay) De Toni ..	Pavnar.
C. quardratum Ralfs	Tiroda.
C. quadratum Ralfs f. Willei West et West.	Amravati.
C. quadrum Lund	Bhandara.
C. quinarium Lund	Bhandara.
C. ralfsii Breb. v. *alpinum* Racib. ..	Amravati.
C. ralfsii Breb. v. *montanum* Racib.	Umred.
C. rectangulare Grun. v. *africanum* West et West.	Umred.
C. regnellii Wille v. *kerguelense* Krieger et Gerloff.	Amravati.
C. regnellii Wille	Dahegaon.
C. reniforme (Ralfs) Arch.	Jawahar Nagar.
C. repandum Nordst. f. *minor* West et West.	Sakoli.
C. retusiformae (Wille) Gutw. ..	Mansar, Tumsar.
C. sexangulare Lund..	Amravati.
C. sexangulare Lund f. *minimum* Nordst.	Amravati, Tiroda.
C. sikkimense Turn.	Amravati.
C. speciosum Lund. v. *ingrassatum* Insam et Krieger.	Jawahar Nagar.
C. striolatum Naeg. v. *nordestedtii* (Moeb.) Krieger.	Umred.
C. subacutangulum Gronbl. ..	Jawahar Nagar.
C. sublatere-undateim West et West	Umred.
C. subreiuschii Schmid. v. *ocellatum* West et West.	Amravati.

Name	Locality
C. subtransiens Croasdale	Tiroda.
C. subtumidum Nordst.	Amravati.
C. subtumidum Nordst. f. *minor* Krieger.	Amravati.
C. subtumidum Nordst. v. *rotundum* Hirano.	Jawahar Nagar.
C. supraconnatum (Turn.) Krieger et. Gerloff.	Bhandara.
C. striolatum Naeg.	Bhandara.
C. trachydermum West et. West ..	Satnavri.
C. trachydermum Lund .. .. v. *nordstedtii* Gutw.	Tiroda.
C. trafalgaricum Wittr.	Wardha.
C. trilobatum Reinsch v. *printzii* Messik.	Umred.
C. triplicatum Wolle	Tumsar.
C. tryolicum (Nordst.) Krieger et Gerloff.	Amravati.
C. tuddalense Strom	Sakoli.
C. tumidum Lund	Tiroda.
C. undulatum Corda ex Ralfs. ..	Umred.
C. undulatum Corda ex. Ralfs v. *crenulatum* (Naeg.) Wittr.	Wardha.
C. undulatum Corda ex. Ralfs v. *minutum* Wittr.	Amravati, Bhandara, Jawahar Nagar.
C. undulatum Corda ex. Ralfs v. *wollei* W. West.	Tiroda.
C. variolatum Lund. v. *rotundatum* (Krieger) Messik.	Bhandara.
C. venustum (Breb.) Arch. .. .. u. *brevis* Bernard.	Satnavri.
C. virde (Corda) Josh. f. *minor* W. West.	Wardha.
C. virde (Corda) Josh. v. *hibernicum* (W. West) Krieger et Gerloff.	Bhandara.
C. wittrockii Lund	Amravati.
Euastrum bidentatum Naeg. .. .. v. *koreana* (Skv.) Okada.	Umred.
E. binale (Turp.) Ehrenb. v. *sectum* Turn.	Dahegaon.
E. ceylanicum (West et West) Krieger	Tumsar, Bhandara.
E. denticulatum (Kirchn.) Gay ..	Mansar.
E. divergens Josh v. *ornatum* (Borge) Schm.	Bhandara.
E. elegans (Breb.) Kuetz. v. *pseudoelegans* (Turn.) West et West.	Umred, Mansar, Amravati.
E. inerme (Ralfs) Lund	Tiroda.

Name	Locality
E. insulare (Witter.) Roy	Amravati, Jawahar Nagar.
E. irregulare Gonz. et Gang... ..	Satnavri, Amravati, Pavnar.
E. turneri West	Bhandara.
E. lutkemuelleri Duc. .. .. v. *carniolicum* (Lutkem.) Krieger.	Mansar.
E. platycerum Reinsch	Umred, Bhandara, Tumsar.
E. spinulosum Delp.	Amravati, Umred, Tumsar, Sakoli, Bhandara.
E. spinulosum Delp. v. *bellum* Scott et Prescott.	Jawahar Nagar.
E. subamoenum Schmidle	Bhandara.
E. sublobatum Breb.	Amravati.
E. sublobatum Breb. v. *obtusatum* (Gutw.) Krieger.	Amravati, Mansar.
E. turneri West	Bhandara.
Microsterias crux-melitensis (Ehrenb.) Hans. ..	Tumsar.
M. foliacea Bailey	Umred, Mansar, Tiroda.
M. mahabaleshwarensis Hobs. v. *chauliodon* Scott et Prescott.	Mansar.
M. pinnatifida (Kuetz.) Ralfs ..	Umred, Tumsar, Bhandara.
M. pinnatifida (Kuetz.) Ralfs v. *pseudoscitans* Gronbl.	Tumsar.
M. radians Turn.	Umred, Mansar, Tumsar.
M. zeylanica Fritsch	Umred, Bhandara.
Xanthidium antilopaeum (Breb.) .. Kuetz. v. *canadense* Joshua.	Mansar.
X. antilopaeum (Breb.) Kuetz. v. *hebridarum* West et West.	Mansar.
X. burkillii West et West v. *alternans* Skuja.	Mansar.
X. hastiferum Turn.	Mansar.
Arthrodesmus convergens Ehrenb. ..	Mansar, Tiroda.
A. curvatus Turn.	Mansar.
A. curvatus Turn. v. *latus* Scott et Prescott.	Umred, Sakoli.
Staurastrum anatinum Cooks et Wille v. *curtum* Smith.	Sakoli.
S. arcuatum Nordst.	Mansar.
S. brebissonii Arch. v. *truncatum* Gronbl.	Bhandara.
S. brevispinum Breb. v. *retusum* Smith.	Amravati.
S. dejectum Breb.	Umred, Bhandara.
S. dickiei Ralfs	Mansar.
S. gladiosum Turn.	Umred.

Name	Locality
S. gracile Ralfs	Tiroda.
S. hantzii Reinsch v. *japonicum* Roy et Bisset.	Mansar.
S. indentatum West et West f. *minus* Scott et Prescott.	Umred.
S. iotanum Wolle v. *longatus* Hirano	Mansar.
S. iotanum Wolle v. *tortum* Teiling	Amravati, Tiroda.
S. leptodermum Lund v. *capitatum* Hirano.	Mansar.
S. longispinum (Bail). Arch. v. *bidentatum* (Wittr.) West.	Mansar.
S. megacanthum Lund	Mansar.
S. orbiculare Ralfs	Akola, Tiroda.
S. orbiculare Ralfs v. *depressum* Roy et Bisset.	Amravati, Bhandara.
S. orbiculare Ralfs v. *ralfsii* West et West.	Tumsar.
S. perundulatum Gronbl.	Akola.
S. pinnatum Turn. v. *subpinnatum* (Schm.) West et west f. *robustum* Krieg.	Umred.
S. polymorphum Breb. v. *pygmaeum* Gronbl.	Bhandara.
S. punctulatum Breb	Umred, Amravati.
S. quadricornutum Roy et Bisset ..	Amravati.
S. retusum Turn. v. *boreale* West et West.	Amravati.
S. saltans Josh. v. *javanicum* Scott et Prescott.	Umred.
S. sexangulare (Bulnh.) Lund ..	Umred.
S. sexangulare (Bulnh.) Lund v. *crassum* Turn.	Umred.
S. tohopekaligense Wolle	Mansar.
S. tohopekaligense Wolle v. *insigne* West et West.	Mansar.
S. unguiferum Turn.	Umred.
Sphaerozosma punctatum West et West.	Umred.
S. vertebratum (Breb.) Ralfs ..	Umred.
Spondylosium nitens (Wall) Arch. f. *majus* Turn.	Umred.
S. planum (Wolle) West et West ..	Umred.
Onychonema laeve Nordst. v. *latum* West et West.	Umred, Tiroda.
O. laeve Nordst. v. *micracanthum* Nordst.	Umred.
Hyalotheca dissiliens (Smith) .. Breb.	Amravati.

Name	Locality
H. indica Turn	Tiroda.
H. mucosa (Mert.) Ehrenb	Umred.
H. undulatum Nordst	Amravati.
Desmidium aptogonum Breb	Amravati.
D. aptogonum Breb. v. *ehrenbergii* Kuetz.	Amravati, Bhandara.
D. pseudostreptonema West et West	Umred, Tiroda.
D. quadratum Nordst.	Tiroda.
Streptonema trilobatum Wall	Umred, Tiroda.
Mougeotia banglorensis Iyengar	Amravati.
M. calcarea (Cleve) Wittr	Amravati.
M. floridana Transeau	Akola.
M. maltae Skuja	Tiroda.
M. microspora Taft	Mansar.
M. reinschii Transeau	Amravati.
M. sphaerocarpa Wolle	Tumsar.
M. transeau Collins	Tiroda.
Zygnema czurdae Randhawa	Amravati, Tiroda.
Z. gangeticum Rao	Tiroda.
Z. globosum Czurda	Amravati.
Zygnemopsis minuta Randhawa	Amravati.
Z. sphaerospora Randhawa	Bhandara.
Spirogyra azygospora R. N. Singh	Tiroda.
S. bichromatophora (Randhawa) Transeau.	Akola.
S. biformis Jao	Wardha.
S. corrugata Transeau	Tiroda.
S. diluta Wood	Satnavri.
S. fennica Cedercreutz	Tiroda.
S. fuellebornei Schmidle	Pavnar.
S. smithii Transeau	Chandrapur.
S. weberi Kuetz	Amravati.

EUGLENOPHYCEAE

Name	Locality
Euglena acus Ehrenb	Chandrapur, Umred.
E. acus Ehrenb. v. *hyalina* Klebs	Khamgaon.
E. acus Ehrenb. v. *oyei* Defl	Amravati.
E. acus Ehrenb. v. *rigida* Hubner	Chandrapur.
E. allorgei Defl.	Akola.
E. caudata Hubner	Akola.
E. charkowiensis Swir	Chandrapur, Akola.
E. charkowiensis Swir. v. *minor* Skovortz.	Chandrapur.
E. chortes Schiller	Umred, Bhandara.

Name	Locality
E. gaumeri Allorge et Lefevre	Amravati.
E. gracilis Klebs	Umred, Khamgaon.
E. ignobilis L. P. Johnson	Akola.
E. limnophila Lemm.	Satnavri.
E. mucifera Mainx	Umred.
E. multiformis Schiller	Akola.
E. oxgyu ris Schmarda	Umred, Khamgaon.
E. pusilla Playfair	Umred.
E. spirogyra Ehrenb	Umred.
E. spirogyra Ehrenb. v. *suprema* .. Skuja.	Mansar, Tumsar.
E. tripteris (Duj.) Klebs	Umred.
Phacus acuminatus stokes v. *indica* (Pochm.) Huber-Pestalozzi.	Amravati.
P. acuminatus Stokes v. *variabilis* Lemm.	Amravati, Mansar.
P. angulatus Pochm.	Bhandara.
P. caudatus Hubner	Umred.
P. circumflexus Pochm.	Umred.
P. contortus Bourr.	Umred.
P. curvicauda Swir	Amravati, Umred, Wardha.
P. sphippion Pochm.	Chandrapur.
P. longicauda (E.) Duj. v. *major* swirenko.	Umred.
P. longicauda (E.) Duj. v. *rotunda* (Pochm.) Huber-Pestal.	Amravati, Akola, Chandrapur, Tumsar.
P. mangini Lafty	Akola.
P. minutus (Play f.) Pochm	Satnavri, Bhandara.
P. orbicularis Hubn.	Umred, Bhandara.
P. pekinensis Skvortz	Khamgaon.
P. platalea Drez	Amravati, Mansar, Bhandara.
P. pleuronectes (O. F. M.) Duj ..	Umred.
P. pseudonordstedtii Pochm. ..	Umred.
P. stokesii Lemm. f. *minor* Conard	Wardha.
P. swirenkoi Ekvortz	Wardha.
P. thrombus Pochm.	Umred.
P. tortus (Lemm.) Skv.	Amravati, Bhandara.
Trachelomonas allia Drez. emend, Defl.	Satnavri, Umred, Bhandara.
T. armata (E.) Stein	Umred.
T. armata (E.) Stein v. *longispina* Playf.	Umred.
T. armata (E.) Stein v. *steinii* Lemm. em. Defl.	Amravati, Bhandara.
T. bacillifera Playf.	Chandrapur.

Name	Locality
T. bacillifera Playf. v. *minima* Playf	Bhandara.
T. bernardinensis W. Vischer em. Defl.	Akola.
T. conica Playf	Chandrapur.
T. cylindrica E. sec. ex Playf. v. *decollata* Playf.	Amravati.
T. dubia Swir. em. Defl. v. *lata* Defl ..	Mansar.
T. dybowskii Drez	Bhandara.
T. globularis Lemm. (Awer.) v. *boyeri* (Palmer) Conr.	Bhandara.
T. hispida (Perty.) Stein em. Defl ..	Amravati, Chandrapur, Mansar, Tumsar.
T. hispida (Perty) Stein em. Defl. f. *recta* Defl.	Bhandara.
T. hispida (Perty) Stein em. Defl. v. *coronata* Lemm.	Amravati.
T. incertissima Defl	Amravati.
T. intermedia Dangeard	Mansar, Bhandara.
T. klebsii (klebs) Defl	Amravati, Bhandara.
T. lacustris Drez	Malegaon, Tumsar.
T. mangini Defl	Bhandara.
T. mucosa Swir. v. *hyalina* Skv. ..	Chandrapur.
T. oblonga Lemm.	Akola, Mansar, Bhandara.
T. oblonga Lemm. v. *australica* Playf.	Chandrapur, Mansar.
T. oblonga Lemm. v. *major* Kamat ..	Umred.
T. oblonga Lemm. v. *truncata* Lemm.	Warora, Mansar.
T. obtusa Palmer	Umred.
T. perforata Awering	Bhandara.
T. piscatoria (Fischer) Stokes ..	Chandrapur.
T. playfairi Defl	Umred.
T. pulcherrima Playf. v. *minor* Playf.	Amravati.
T. raciborskii Wolosz	Bhandara.
T. robusta Swir. em. Defl.	Bhandara.
T. scabre Playf	Amravati.
T. scabra Playf. v. *ovata* Playf. ..	Amravati.
T. similis Stokes	Bhandara.
T. superba Swir. em. Defl	Tumsar.
T. sydneyensis Playf.	Bhandara.
T. variana Defl	Umred, Bhandara.
T. volvocina Ehrenb	Amravati, Bhandara, Tiroda.
T. volvocina Ehrenb. f. *minuta* Fritsch	Amravati.
T. volvocina Ehrenb. v. *derephora* Conrad.	Mansar, Tumsar.

Name	Locality
T. volzii Lemm. v. *cylindrica* Playf ..	Umred.
T. volzii Lemm. v. *pellucida* Playf.	Umred.
T. wermelii Skv.	Bhandara.
T. woycickii Koczwara v. *bombayensis* Kamat.	Mansar.
T. woycickii Koczwara v. *pusilla* Drez.	Amravati.
Strombomonas fluviatilis (Lemm.) Defl.	Bhandara.
S. maxima (Skv.) Defl.	Chandrapur.
S. napiformis (Playf.)Defl. v. *brevicollis* (Playf.) Defl.	Bhandara.
S. ovalis (Playf.) Defl.	Chandrapur.
S. urceolata (Stokes) Defl	Amravati.
Lepocinclis glabra Drez. f. *minor* Prescott.	
L. marssonii Lemm. em. Conard ..	Tumsar.
Menoidium gracile Playf	Umred.
Anisonema acus Duj	Mansar.
XANTHOPHYCEAE	
Ophiocytium elongatum West et West.	Umred.
Botrydium granulatum (L.) Greville	Sakoli.
DINOPHYCEAE	
Cystodinium iners Geitler	Mansar.
Massartia stigmatica (Linden) Soiller.	Amravati, Tiroda.
Gymnodinium neglectum (Schill.) Lind.	Mansar.
G. rotundum Klebs	Bhandara.
Glenodinium gymnodinium Penard ..	Katol.
G. guadridens (Stein.) Schiller ..	Tiroda.
Peridinium bipes Stein	Tumsar.
P. cinctum (Muell.) Ehrenb ..	Chandrapur.
P. palustre (Lindem.) Lef. v. *raciborskii* (Wol.) Lef.	Bhandara.
P. penardiforme Lindem.	Tiroda.
P. pusillum (Penard) Lemm. ..	Amravati.
CYANOPHYCEAE	
Microcystis aeruginosa Kuetz ..	Tumsar, Tiroda.
M. flos-aquae (Witrr.) Kirchn ..	Tumsar.
Aphanocapsa grevillei (Hans.) Rabenh.	Satnavri.

Name	Locality
A. testacea Naeg	Tiroda.
Aphanothece castagnei (Breb.) Rabenh.	Bhandara.
A. heterospora Rabenh	Tiroda.
A. microscopica Naeg	Tiroda, Bhandara.
A. pallida (Kuetz.) Rabenh ..	Mansar, Chandrapur, Khamgaon.
Gloeocpasa muralis Kuetz	Amravati.
Gloeothece geoppertiana (Halse) Forti.	Wardha.
G. rupestris (Lyngby) Born	Khamgaon.
G. samoensis Wille	Amravati.
Chroococcus minor (Kuetz.) Naeg ..	Amravati.
C. minutus (Kuetz.) Naeg. ..	Wardha, Khamgaon.
C. minutus (Kuetz.) Naeg. v. *obliteratus* (Richt.) Hansg.	Akola.
C. pallidus Naeg.	Wardha.
C. spelaeus Ercegovic	Tiroda.
C. turgidus (Kuetz.) Naeg.	Wardha.
C. turgidus (Kuetz.) Naeg. v. *maximus* Nygaard.	Tiroda.
C. turicensis (Naeg.) Hansg ..	Amravati, Khamgaon.
C. westii (W. West) Boye-Pet. ..	Yeotmal, Tumsar, Bhandara.
Merismopedia elegans A. Br. ..	Wardha, Tiroda.
M. glauca (Ehrenb.) Naeg.	Jawahar Nagar, Tiroda, Wardha.
M. punctata Meyen	Wardha, Chandrapur, Pavnar.
M. tenuissima Lemm.	Amravati.
Synechococcus cedrorum Sauv. ..	Amravati.
S. aguatilis Sauv.	Amravati.
S. crassa Woronic.	Amravati.
S. sallensis Skuja	Amravati.
Myxosarcina burmensis Skuja ..	Bhandara, Tiroda.
M. spectabilis Geitler	Umred.
Chamaesiphon sideriphilus Starm. v. *glabra* C. B. Rao.	Yeotmal.
Borzia trilocularis Cohn	Amravati, Khamgaon.
Spirulina major Kuetz. ex. Gomont	Amravati, Wardha, Tiroda.
S. meneghiniana Zanard	Wardha, Lonar.
S. princeps West et West ..	Tumsar.
S. subsalsa Orest. v. *crassior* Virieux	Lonar.
Arthrospira platensis (Nordst.) Gomont.	Yeotmal.
A. tenuis Bruhlet Biswas	Amravati.
Oscillatoria agardhii Gom	Gondia.
O. amphibia Ag. ex Gom.	Wardha, Mansar, Tumsar.
O. angusta Koppe	Satnavri.

Name	Locality
O. annae Van Goor	Wardha.
O. boryana Bory ex Gom.	Yeotmal.
O. brevis (Kuetz.) Gom.	Akola, Tiroda.
O. chalybea (Mertens) Gom. ..	Amravati, Akola, Lonar.
O. claricentrosa Gardn	Umred.
O. cortiana Menegh. v. *minor* Kamat	Chandrapur.
O. decolorata G. S. West	Umred.
O. formosa Bory ex Gom.	Amravati.
O. geminata Menegh. ex. Gom. ..	Katol.
O. jasorvensis Vouk	Tiroda.
O. mougeotii Kuetz	Satnavri, Yeotmal, Umred.
O. nigro-viridis Thwaites	Wardha.
O. okeni Ag. ex Gom.	Yeotmal, Khamgaon.
O. ornata Kuetz. ex Gom. v. *crassa* C. B. Rao.	Wardha, Chandrapur.
O. princeps Vauch	Wardha.
O. proboscoidea Gom.	Wardha, Satnavri.
O. profunda Kirchn	Tiroda.
O. pseudogeminata G. Schmid f. *longa* Kamat.	Satnavri, Akola, Tiroda.
O. quadripunctulata Bruhl et Biswas	Sakoli.
O. quadripunctulata Bruhl et Biswas v. *unigranulata* R. N. Singh.	Satnavri, Umred.
O. rubescens D. C. ex Gomont ..	Amravati, Umred, Akola.
O. raciforskii Wolosz.	Bhandara.
O. schultzii Lemm. v. *cylindrica* Kamat. ..	Wardha, Chandrapur.
O. simpliciassima Gom.	Tumsar.
O. splendiad Grev. ex Gom. ..	Satnavri, Sakoli, Tiroda.
O. splendiad Grev. ex Gom. v. *attenuata* West et West.	Vena Dam.
O. subuliformis Kuetz. ex Gom. ..	Lonar.
O. tambi Moron	Amravati.
O. tenuis Ag. v. *tergestina* Rabenh. ..	Yeotmal.
O. ulrichii Prat	Gondia.
Phormidium corium (Ag.) Gom. ..	Amravati.
P. crossbyanum Tild.	Tiroda.
P. foveolarum Gom.	Chandrapur.
P. frigidum Fritsch	Amravati.
P. jenkelianum G. Schmid	Satnavri.
P. molle Gom.	Amravati.
P. mucicola Huber-Pest. et Naumann	Tiroda, Bhandara.
P. stagnina C. B. Rao	Chandrapur, Wardha.
Lyngbya allorgei Fremy v. *granulata* Kamat.	Satnavri.

Name	Locality
L. birgei G. M. Smith	Tumsar.
L. confervoides Ag.	Wardha.
L. endophytica Elenk. et Hollerb ..	Umred.
L. gandhii Kamat	Amravati.
L. hieronymusii Lemm.	Umred.
L. holsatica Lemm.	Wardha.
L. lachneri (Zimm.) Geitler v. *minor* Geitler.	Tiroda.
L. limnetica Lemm.	Tiroda.
L. majuscula Harvey ex Gomont ..	Satnavri.
L. martensiana Menegh. ex Gomont	Chandrapur.
L. shackletoni West et West ..	Tiroda.
L. spiralis Geitler	Satnavri.
Microcoleus chthonoplastes Thuret ex Gomont.	Sakoli.
Anabaenopsis arnoldii Apte. v. *indica* Ramnathan.	Lonar.
A. circularis (G. S. West) Wolosz. et Miller.	Mehkar.
A. raciforskii Wolosz	Gondia.
Raphidiopsis mediterranea Skuja ..	Mansar, Katol.
Cylindrospermum licheniforme Kuetz. ex Born. et Flah.	Amravati.
C. majus Kuetzing ex Born. et Flah	Amravati.
C. muscicola Kuetz. ex Born. et Flah.	Bhandara.
C. stagnale (Kuetz.) Born. et Flah.	Amravati, Tiroda.
Anabaena fuellebornii Schmidle ..	Tumsar.
.*Aineagualis* (Kuetz.) Born. et Flah.	Umred.
A. orientalis Dixit	Tumsar.
A. sphaerica Born. et Flah. ..	Mehkar.
A. volzii Lemm.	Amravati, Wardha.
Nodularia spumigena Mertens ..	Lonar.
Nostoc microscopicum Carm. ex Born. et Flah.	Bhandara.
N. paludosum Kuetz. ex Born. et Flah.	Umred, Bhandara.
N. rivulare Kuetz. ex Born. et Flah.	Sakoli.
Aulosira fertilissima Ghose v. *tenuis* C. B. Rao.	Amravati, Akola.
A. implexa Born. et Flah. v. *crassa* Dixit.	Amravati, Chandrapur.
Camptylonemopsis pulneyensis Desik.	Tumsar.
Scytonema chiaetum Geitler ..	Amravati.
S. cookei W. et G. S. West ..	Amravati.

Name	Locality
S. simplex Bharadw.	Tiroda.
Fortiea bossei (Fremy) Desik. ..	Amravati.
Calothrix clavatoides Ghose ..	Akola.
C. siphytica West et West	Tumsar.
C. karnatakensis Gonz. et Kamat v. *major* Gonz. et Kamat.	Amravati.
C. marchica Lemm.	Bhandara.
C. wembaerensis Hieron et Schmidle	Tumsar.
Dichothrix orsiniana (Kuetz.) Born. et Flah.	Amravati.
Gloeotrichia intermedia (Lemm.) Geitler v. *kanwanensis* C. B. Rao.	Chandrapur, Bhandara.
G. natans Rabenh. ex Born. et Flah.	Sakoli.
G. pilgeri Schmidle	Bhandara, Mansar, Amravati.
G. raciborskii Wolosz.	Sakoli.
G. raciborskii Wolosz. *kashiense* .. C. B. Rao.	Amravati.
apalosiphon baronii West et West ..	Mansar.
H. hibernicus West et West ..	Mansar.

SECTION B—FUNGI

1. GENERAL INTRODUCTION :

Fungi constitute the second important group of Thallophyta. They do not have much differentiation of parts and are unicellular or multicellular, simple or filamentous, uninucleated but often coenocytic, with or without septa. Their vegetative system is very simple, but the reproductive system is not so ; it is often complex. They mainly reproduce by spores produced in a variety of spore-producing organs. Some have different kinds of spores also.

They are a very ancient group of plants. They can live and thrive in water, under snow, in soil, in air, and can live even on mineral nutrition obtained from hard early rocks. There is no place where they are not to be found. Even some of the spores photographed from exosphere appear to be the spores of Fungi found in the meteorites. The constituents of some meteorites when analysed contained some amino acids found in the living organisms on earth. They thus appear to be the most ancient organisms. On young earth and in primaeval seas, they are supposed to have lived heterotrophically. It was not until chloroplasts developed in some organisms that they got intruded in them and started living with them, almost symbiotically if not parasitically, before the plants came into being. There is another view of certain scientists like Martin (1950), Schoop etc. Martin (1950) thinks that Fungi have been derived from animals, or at any rate from organisms which were omnivorous and parasitised on them in early eras. The organisms which developed chlorophyll became plants and which did not became Fungi. For want of chlorophyll they had no power of photosynthesis.

The total number of Fungi in the world is very large, practically one-half of the species of plant kingdom, and as many as flowering plants. Since they evolved from Proterozoic times, they got variously differentiated into many forms ; and being prolific in reproduction, multiplied and spread all over the world in course of time. Some of them disappeared in competition for existence but others survived. For example, we find fungal mycelia in the earliest Vascular plants—the Rhyniaceae of the Devonian period. In the process, since some types could not compete with others, the more aggressive and virulent types survived. They multiplied enormously in the carboniferous period. They were mostly Phycomycetes. From the Triassic period we come across higher fungi and the Imperfect fungi, which got associated with the roots of the then prevalent vegetation of conifers and lived symbiotically as mycorrhiza, and others perhaps lived parasitically. It was during the latter part of the Mesozoic period, especially during the Cretaceous period that they developed numerous types which got associated with the higher plants like gymnosperms and flowering plants which had evolved suddenly. They found new hosts and habitats in flowering plants. According to Leppik (1955), and Pirozinsky and others the evolution of flowering plants and higher fungi like rusts and smuts synchronized with the evolution of the flowering plants, but the maximum differentiation of higher fun is of later origin. Leppik (1955) has shown (Table No. II.7) ŀ development of the specialization of some main groups of Rust Fu

Sorosporeae (former Melampsoraceae on Abitinaeceae), Pucciniceae and Gymnosporangiaceae have evolved side by side historically.

TABLE No. II·7

Historical development of the specialization of some main groups of rust fungi. Sorosporeae (former on Abietaceae), Pucciniceae and Gymnosporangiaceae

Era (1)	Stages of development (2)	Sorosporeae on woodland plants (3)	Pucciniaceae on grassland plants (4)	Gymnosporangiaceae on mountain plants (5)	Time elapsed in millions of years (6)
		Higher Angiosperms			
Cenozoic	Rostelioid	Salicales	Glumiflorae	Pomaceae	60
Mesozoic	Telioid	Abietaceae	Ranales	Cupressaceae.	
	Aecioid	Ancient	Coniferous	Rusts	200
Paleozoic	Uredinioid	Ancient	Fern	Rusts	
	Probasidioid.		Auriculariles		300

(After Leppik 1955, p. 157).

They attacked any wild plants which provided them with suitable nutrition. They evolved several metabolic processes and nutritional mechanisms, and physiologic races. The fungi thus today are the largest group of plants in water, soil, air, on other plant groups, crops and forest trees, animals, insects, etc. Even man has not escaped their attack. It is essential, therefore, that everyone should have some knowledge of Fungi. The following pages describe some plant diseases in Maharashtra and their causal organisms. There are many books on plant diseases and their control and it is not intended to repeat them here.

2. Brief History of Studies on Fungi in Maharashtra :

In Maharashtra the tradition of studying and describing fungi and diseases is very old and perhaps the oldest in the country. Study of mycology in the State dates as far back as 1886 when Kirtikar described *Agaricus astreatus*, growing on *Artocarpus integrifolia* Linn. It was thought by Dymock (1886) to be a *Polyporus*, but on re-examination it turned out to be *Agaricus* renamed as *Boletus nitens-artocarpalis* Kirtikar. But even that name is no longer valid. Kirtikar wanted to publish a monograph on fungi of Bombay on the material he had collected and that collected by Justice Birdwood of the Bombay High Court ; but it never materialised. Dalgapto (1898) while describing the *Flora of Goa and Sawantwadi*, included the Fungi in it. By 1904 Father Ethelbert Blatter S. J. had come to India and started teaching Biology with the help of local plants and animals at the St. Xaviers College, Bombay. He himself

published in 1911, in *Journal of the Bombay Natural History Society* Vol. 21, pages 146-152 a list of about fifty higher fungi, from a German paper based on the material he had collected and identified by Theissen (1911) ; later Theissen (1911) himself published a more comprehensive paper in *Journal of the Bombay Natural History Society*, Volume 21, pages 1274 -1403 on the Fungi of Bombay. By that time the College of Agriculture at Pune was organised as a college separated from the then College of Science located in what is at present the College of Engineering. Mycology and Plant Pathology laboratory was organized in College of Agriculture, Pune and this gave a great incentive to the study of Fungi and plant pathology. In 1911, Chibber (1911) issued a working list in diseases and vegetables pests of some economic plants occurring in Bombay Presidency, which was enlarged by him in 1914 as *Bulletin No. 65* of the Department of Agriculture, Government of Bombay. In the meantime early in the beginning of 1914 during the World War I, Professor S. L. Ajrekar, B. A. Cantab, I. E. S., joined the College of Agriculture as Professor of Mycology and Plant pathology at the Agricultural College, Pune, and was assisted by Kulkarni, Kamat, etc. They studied Jowar smut and the downy mildew on bajra and jowar. Then came Uppal who jointly with Patel and Kamat published in 1935 a consolidated list of the *Fungi of Bombay* as *Bulletin* No. 176 of the Department of Agriculture, Bombay. This list contained 593 Fungi belonging to all groups and a short account of viral and other diseases. This was amended by Patel, Kamat and Bhide(1949) who included several new fungi described by later workers. Very recently a much more comprehensive list of Fungi of Maharashtra comprising so many new genera and species has been compiled jointly by Kamat, Patwardhan, Rao and Sathe (1974). It is published by the Mahatma Phule Krishi Vidyapeeth of Rahuri as *Bulletin 1*. This contains a fairly upto-date list of Fungi in Maharashtra including those of Berar, Nagpur and Marathwada. It consists of 1,269 species belonging to 346 genera, including two genera of Sterile mycelia, two of Myxomycetes, 31 of Phycomycetes, 86 of Ascomycetes, 97 of Basidiomycetes and 140 of Fungi Imperfecti which forms the largest group. This number is fairly comparable with the list given by Butler and Bisby (1918) which gives 2351 *Fungi of India*, some new additions were supplemented later by Mundkur (1934) and again in a second supplement by Tilak and Rao (1965). This makes a huge addition to the Fungi of India including Maharashtra. There is a great spurt today for the work on Mycology all over India. Numerous workers in Maharashtra and elsewhere like Tilak, Patil, Payak, Rajderkar, Deshpande, Chiddarwar Rao, Sathe, Vaidya, etc. who have added to them. Excellent works on their morphology, symptoms, life history, cytology, control measures are given in these works on Mycology and Plant Pathology and the reader is referred to them for further information. Only important pathogenic fungi on plants, especially those causing serious diseases to economic plants like crops, fruits, vegetables, forest trees and man are given here. They do not claim to be exhaustive and have been briefly treated.

The list of fungi of erstwhile Bombay State enlisted by Uppal, Patel and Kamat in 1935 were subsequently revised by Patel, Kamat and Bhide in 1949, covering fungi of the whole region falling under Bombay Presidency. After the separation of Sindh, Gujarat and Karnatak, it was necessary to revise and relist the fungi occurring in Maharashtra State as now constituted. This list has been published in 1971 as a *Bulletin* No. 1 of Mahatma Phule Krishi Vidyapeeth, Rahuri, written by M. N. Kamat, P. G. Patwardhan, V. G. Rao, A. V. Sathe of the Mycology Department of Maharashtra Association for the Cultivation of Science,

Pune. It gives the fungi listed earlier, and those added by later authors who have made substantial additions since 1953. Not less than 6 new genera and 300 species have been added. The total number of species of fungi in Maharashtra now comes to 92 Phycomyceats, 206 Ascomycetes, 280 Basidiomycetes and 703 Fungi imperfecti. The important among these are species of *Alternaria*, *Cercospora*, *Elsinoe*, *Erysiphae*, *Synchytrium Parodiella*, *Phyllachora*, *Phyllosticta*, *Physoderma*, *Septoria*, *Synchytrium*, Black spot fungi and rust fungi and many leaf litter fungi belonging to Hyphomycetes investigated by S. D. Patil and Kamat, Patwardhan, Rao and Sathe (1971).

Some strange observations regarding them deserve mention here. The genus *Parodiella* is unusually confirmed in this State to legumes. The black or dark spot genus *Phyllachora* has a wide variety of hosts both, dicot and moncot. In monocots they are mostly found at low altitude, but on dicots they occur at high altitude 2000'-4000'. The perithecial stages of Powdery mildews are found generally in winter months—November to February. A hyper-parasite *Ampelomyces* is also found on *Erysiphopsis* in rainy season—August-September and is confined only to *Acalypha* species. Some new genera such as *Narasimhella*, *kamatomyces*, *Ajrekarella*, *Chlamydorubra*, *Cyclodeomella*, *Mahabalella*, *Tawdiella*, *Volutellospora*, belonging to Imperfect fungi were newly noted. The flora of Maharashtra appears to be very rich in Fungi Imperfecti. Diseases of fruits and vegetables human pathogens have been reported by Hindustan Antibiotics Ltd., Pimpri and new fungi giving antibiotics. They also have been included here. A large fungal reference collection has been built at Maharashtra Association for Cultivation of Science, Pune since 1953, and it is deposited in the Ajrekar Herbarium which is now internationally recognised for depositing fungal type specimens.

3. Classification of Fungi :

Classification of fungi is based mainly on the presence or absence of reproductive bodies, but some of them do not have them or show them. They are generally put under '*Imperfect Fungi*', many of which cause serious plant diseases on wild and cultivated plants.

It should always be remembered that every fungus anywhere, even on wild plants is a potential pathogen. The classification here, therefore, merely indicates the accepted taxonomic system followed by mycologists in general.

(1) *Myxomycetes*.—These are slime mold fungi having two sub-classes and seven Orders depending upon the presence or absence of peridium. They are not pathologically important except Club-root of Crucifers caused by *Plasmodiophora*.

(2) *Phycomycetes* or Algal fungi.—They are a well knit group. They have three sub-classes and 10 Orders and 24 families. They cause some serious diseases of fruits, vegetables, and even of man. *Pythium*, *Monoblepharis*, *Physoderma* are typical examples of them. Diseases caused by them on economic plants are given in List 2. They have motile gametes and two laterally ciliated zoo-spores and variously shaped conidia. Sporangium formation is the usual method of reproduction. They however reproduce sexually when their + and – strains are grown together.

(3) *Ascomycetes*.—This group is very important pathologically. They are quite complex compared to lower fungi and reproduce by the formation of various bodies called ascocarps which produce asci having endogenously formed ascospores. They live as saprophytes and parasites on a

variety of plants, in soil, in water, etc. *Aspergillus*, *Penicillium* are specially important. They form Molds, Powdery and Sooty mildews, Brown rot, scab in important crop plants like bajra etc. They form Ergot of Rye. Importance of *Penicillium* need not be told since its species *P. chrysogenum* and *P. notatum* are the source of well-known antibiotic 'Penicillin'. There are various species of *Aspergillus* which are added to alcohol for flavour. Ascomycetes reproduce by two phases, conidial or asexual phase, and Ascigerous phase producing asci. It is the sexual reproductive phase of the plant. Sexual process and diplodisation are quite complex processes. Formation of fruit bodies or ascocarp is common. They have 2 sub-classes, 15 Orders and 36 families. Some of these fungi are highly destructive, but some of them are quite useful and yield important drugs and auxins, particularly *Claviceps purpurea* which gives Ergotine, *Gibberella* gives the well-known auxins Giberellins. The diseases caused. by them are listed in Table II-8.

(4) *Basidiomycetes*.—This group includes more than 25,000 species It is highly advanced and forms exogenously basidisopores usually 2-4 rarely 8, produced on basidia. Some of the diseases caused by them on jowar, bajra, onion, figs, grapes are very destructive. The largest number of plant diseases are caused by them. They reproduce both asexually and sexually also by formation of spermatia, uredia and other type of spores by the process of diplodisation and somatogamy. Their taxonomy is based on the form of basidium. Rust of wheat and other plants, and smuts caused by them are typical examples. There are two sub-classes, 2 Orders and 27 families. *Ustilago*, *Mundkurella*, *Tilletia*, *Uromyces*, various rusts, smuts and bunts are some examples.

Over a thousand species of smuts belonging to Ustilaginales and over 40 rusts (Uredinales) are known. Rust reproduce by the formation of different spores, some times on the same plant and some times on a different plant serving as an alternate host. They cause great damage to wheat crop, coffee, etc. They show heterothallism. They have various physiological races of which about 11 occur in India. The testing of wheat strains for resistance and pathogenacity on a particular strain of wheat rust is done at Mahabaleshwar at the Regional Wheat Rust Research Station. Account of it is given separately.

(5) *Fungi Imperfecti*.—These are a provisional group, which reproduce by vegetative reproduction forming conidia. Their sexual or perfect stage is not known in most cases. Examples are *Cercospora* on groundnut, wilt caused by *Fusarium* in cotton, pigeon pea etc. They are of considerable economic importance. Their classification is artificial depending upon the acervuli, pycnidia, synnemata and on conidia—whether 1-celled or 2-celled, and whether they are globular, cylindrical, ovoid or oblong. Some times the conidia are hyaline or may be coloured, smooth or muri formed. They cause wilt of cotton and other plants, diseases on pineapple, and red-rot of sugarcane etc. They have 4 Orders and 9 families. They are associated with forest trees and grasses as mycorrhiza.

(6) *Mycelia Sterilia*.—*Mycelia sterilia* is the last group of fungi. It has not been well studied, and full details are not available. They are sterile but cause a few diseases of plants.

4. Mycology and Plant Pathology

The study of fungi forms the subject matter of mycology. It has both fundamental and applied aspects. The fundamental aspects deal with the

major theoretical problems of classification, taxonomy, life cycles, reproduction, cytology, genetics etc., irrespective of the utility of the information gathered. It provides continuously new streams of ideas and materials to the workers for research ; whereas the applied mycology deals with the information gathered as applied to a particular problem or a topic under consideration. Its scope, therefore, is necessarily limited and has particular aim in view to achieve. Since fungi are universal, their control also has to be universalised. The main fields of application to human affairs are Agriculture, Horticulture, Industry, Food, Medicine, Forestry, Water, Hygiene. The fungal spores being small and light are always floating in air and affect man, and other animals who inhale them. They settle on crops and often cause diseases both to crops, animals and men. Therefore, special precaution has to be taken against the incidence and spread of fungal spores causing asthema and other lung diseases. The fungal spores settle on any moist surface anywhere and viciate it. So precautions have to be taken that they do not break out in huge numbers causing epidemic. Study of all plant diseases and their control is the subject matter of Plant Pathology.

5. World Population, Food and Fungi :

The quantity of food produced in the world is always insufficient for the numbers that live on earth. Many countries except America have to import food grains, oil seeds etc. Along with them come seed borne fungal spores from foreign lands. Every country, therefore, has to take preventive measures against them by way of '*Plant Quarantine Regulations*', especially against the live materials such as fruits, vegetables bulbs, tubers etc. Generally any foreign material to be brought in the country has to be certified as free from disease or infection by the exporting country ; otherwise it is detained in Plant Quarantine at the point or port of importation. Seeds and grains are generally fumigated by sulphur dioxide or dusted with fungicides, it being easy to do so, and is effective also ; but with the live material it is only the surface sterilization that is achieved by this method. The causal organisms could be much deeper inside and, therefore, a certificate by the quarantine authorities of that country is required stating 'No objection' for export. Government of India also has made similar arrangement and passed Indian Plant Quarantine Rules of 1914, amended from time to time.

Another source of importing alien pathogens is the tree saplings and vegetative slips. Very often good and high yielding fruit trees, ornamentals and other economically useful plants, for timber, fiber, paper, medicines etc. have to be imported. This is done generally at the State level or the country level by the 'Bureau of Plant Introduction' who take all care while importing a particular plant either for industry or for food, beverages, medicines and such other utility purposes and see that they do not import diseased material. There is a 'Bureau of Plant Introduction' at the Central Agricultural Research Institute at Delhi. Some material required by a scientific worker for research, brings it with him open or concealed. He unknowingly gets trapped. Material is generally confiscated and destroyed and person warned ; and still the piracy of important fungi or other materials having ability for a particular chemical product or an antibiotic, or for producing epidemic goes on from country to country all over the world. It is as common as the exchange of research materials. However, the spores coming in a country through aeroflora as 'Air borne spores' can never be stopped ; only preventive hygienic measures can minimise the ravages due to air borne spores. Like patented machines and processes, certain fungal spores,

their culturing and processing methods are also patented. e. g. *Mucor* strains which produce citric acid, *Aspergillus oryzae* producing 'Sake' and other wines, various strains of yeast producing high grade wines and liquors etc.

Still another source of really terrible infection introduced in the country is the small weed seeds. Many of them came with foodgrains or attached to the baggage of air passengers, and to aeroplane parts. In these days of fast air travel weed seeds also travel equally fast and spread infection from one country to another. In a new country there is less competition to them and they spread and prosper enormously. The latest and the most destructive weed in India today is *Parthenium histerophorus*, a compositae weed. Similarly the bispinous fruits of *Amarantus bispinosus* came to India during World War I from the Middle East countries with troops. The plant quarantine and plant protection rules are not enough to stop the evil of import of the weeds and fungi that come with them.

6. Fungi Causing Plant Diseases :

Quite a large number of fungi cause diseases to plants and destroy them, or damage the yield. In this, the bacteria, fungi, viruses and insects play title role. Of all these, plants suffer most due to fungal diseases, because they damage man's crops, his food, his lumber, clothes, paper, pollute his food, and water. Therefore the important of them are described here as under and then other general topics :—

1. Fungal diseases of crop plants-cereals, pulses, oil seeds, spices and condiments.
2. Diseases of fruits in storage in market.
3. Bacterial diseases of fruits and vegetables.
4. Diseases of vegetables in storage in market.
5. Fungi on medicinal plants.
6. Fungi on ornamental plants.
7. Diseases of forest trees.
8. Bacterial plant diseases.
9. Viral and other diseases due to worms etc.
10. Wood rotting fungi.
11. Soil fungi.
12. Useful fungi ; their industrial uses.
13. Fungal diseases of man.
14. Yeast and fermentation.
15. Antibiotics.
16. Food spoilage and mycotoxins, etc.

6·1 CEREALS

TABLE No. II-8

Fungal Diseases of Cereals in Maharashtra

Serial No.	Host	Disease	Causal organism	Parts affected	Control/Remarks
(1)	(2)	(3)	(4)	(5)	(6)
1	RICE				
	Oryza sativa	Blast	*Piricularia oryzae*	Seedling	Seeds to be treated with perenox (1/50 1-2).
	Do.	Bunt (Black smut)	*Neovassia horrida*	Ovaries	Removal of infected parts.
	Do.	Head blight (Rati)	*Helminthosporium oryzae*	Leaves	Seed treatment with perenox.
	Do.	Agarbati	*Ephelis oryzae*	Ear	Roguing of affected heads.
	Do.	False smut (Green smut)	*Ustilaginoidea virens*	Grains	..
	Do.	Sclerotial disease	*Sclerotium rolfsii*	Plants show tillering sterility of grains.	Not known.
2	JOWAR				
	Sorghum vulgare	Grain smut	*Sphacelotheca sorghi*	Ovaries	Treat seed with sulphur (4.60) and sow.
	Do.	Leaf shred	*Sclerospora sorghi*	Leaf	Flooding seed before sowing.
	Do.	Leaf rust	*Puccinia purpurea*	Leaf	Grow resistant varieties.
	Do.	Kharkharia disease or hollow stem.	*Macrophomina phaseoli*	Stem	Long rotation avoid lodging.
	Do.	Sugary disease	*Sphacelotheca graminicol*	Ovaries	Not known.
	Do.	Sheet spot	*Collectorichum sorghi*		

3	WHEAT *Triticum aestivum*				
		Black stem-rust	*Puccinia graminis* var. *triticum*	Stem	Grow resistant varieties.
		Leaf rust	*Puccinia tritici*	Leaves	Grow resistant varieties.
		Foot rot	*Fusarium* sp. *and Pythium graminicola.*	Seedling blight	Treat seeds with TMTD (2-60).
		Loose smut	*Ustilago tritici*	Inflorescence	Solar heat treatment.
		Head light	*Fusarium culmorum*	Ears	Grow resistant varieties.
		Leaf mould	*Cladosporium herbarum*	Leaves	Store grains well drained and in cocl ventilated.
4	BAJRA	Leaf rust	*Puccinia penniseti*	Leaves	Resistant varieties may be selected.
		Pennisetum typhoides Stapf. and Hubbard.			
		Green ear	*Sclerospora graminicola*	Leaves	Systematic removal in early stages.
		Smut	*Tolyposporium penicillariae*	Grains	Systematic removal of attacked heads.
		Ergot	*Claviceps microcephala*	Ear head	Obtain seed from disease free areas.
5	MAIZE				
	Zea mays	Dawny mildew	*Sclerospora sorghi*	Leaves	Systematic *reducing* in young stage.
		Brown spot	*Physoderma maydis*	Leaves rodes	Long rotation.
		Seedling blight	*Fusarium* sp.	Seedling	Dry seed treatment with Nomersa or Agrosau GN (3 oza-60 lles) before seeding.

6·2. PULSES AND LEGUMES

TABLE No. II-9

Fungal Diseases on Pulses and Legumes in Maharashtra

Serial No. (1)	Name of the Host (2)	Disease Fungi Imperect (3)	Causal organism (4)	Parts affected (5)	Control/Remarks (6)
1	*Cajanus cajan* (L.) Mills.	Wilt	*Fusarium oxysporum*	Leaves	Very difficult to control.
2	*Phaseolus vulgaris* L. (Beans group).	Ascomycetes powdery mildew.	*Erysiphae polygoni*	Leaves	Sulphur dusting.
3	*Glycine soja* *Merr.* (Soybean).	Downy midew	*Peronospora* sp.	Leaves	Spray half grown plants with Bordeaux mixture (3-5-50) one or two times at 3 weeks interval.
4	*Pisum sativum*	Rust	*Uromyces fabae* (Pers) de Bary	Leaves	Dust crop atflowering time with fine sulphur dust (25 per acre).
		Downy mildew	*Peronospora viciae*	Leaves	
		Powdery mildew	*Erysipha polygoni.*	Shoots pools flowans.	
	Lens esculentus Moucuch.	Dry rot	*Uromyces fabae*		
			Fusarium arthoceros		
6	*Cicer arientinum* L.	Leaf spot	Pycnidial stage Phyllostictaspp Perfect stage *Mycosphaerella*	Leaves	Chemical treatment.
7	*Phaseolus mungo* L. var. *radiatus* Black gram.	Any part	..	..	.. ..
	Phaseolus mungo L.	Leaf spot	*Cercospora canescens*	Leaves	.. ..
		Powdery mildew	*Erysipha polygoni*		
8	*Phaseolus mungo* (Mung).	Powdery mildew	*Erysiphe polygoni*	Leaves	Dusting plants with 300 mesh sulphur early.
9	*Dolichos lablab* L.	Powdery mildew	*Ovulariopsis macrospora* *Colletotrichum lindemithianum*	Leaves, sleari etc.	Airborne spraying of Bordeaux mixture.

6.3. OILSEED PLANTS

TABLE No. II-10

Fungal Diseases on Oilseed Plants in Maharashtra

Serial No. (1)	Name of the Host (2)	Disease (3)	Causal organism (4)	Parts affected (5)	Distribution (6)	Control Remarks (7)
1	*Arachis hypogea* L. (Groundnut).	Tikka	*Cercospora arachidicola*	Leaves	Maharashtra	Grow early maturing foreign varieties, avoid local varieties.
		Rust	*Puccinia arachidicola*	Leaves	Do.	Proper fungicide-Daconil.
		Root rot	*Sclerotium rolfsii*	Plants	Do.	Systematic *rogueing*.
2	*Linum usitatissimum* L. (Linseed) (Jawas, Alshi).	Wilt	*Fusarium lini*	Adult plant	Do.	Growing resistant varieties.
3	*Ricinus communis* L. (Castor Oil).	Rust	*Melamspora ricini*	Leaves	Do.	Spray plants with Bordeaux mixtures (3-3-50).
4	*Sesamum indicum* DC	Leaf spot	*Cercospora sesami*	Leaves	Do.	Airborn.
5	*Carthamus tinctorius* L. (Safflower).	Rust	*Puccinia carthami*	Cotyledones Young leaves.	Do.	Controlling chemical. treatment.
6	*Helianthus annuus* L. (Sunflower).	Rust	*Puccinia helianthi*	Leaves	Do.	Spray Bordeaux mixture (3-3-50).
7	*Guizotia abyssinica*	Leaf spot	*Alternaria tenuis*	Leaves	Do.	..
8	*Papavar somniferum* L. (Poppy or Aphi aphu).	..	*Peronospora adelocaryia*	Leaves	Rarely cultivated	..

6.4. SPICES AND CONLIMENTS

TABLE No. II-11

Fungal Diseases on spices and Condiments giving Plants

Serial No. (1)	Name of the Host (2)	Disease (3)	Causal organism (4)	Parts affected (5)	Distribution (6)	Control/Remarks (7)
1	*Curcuma longa* L. ..	.. Leaf spot Rhizome and Root rot.	*Taphrina maculans* *Colletot*richum capsici.	Leaf.		..
2	*Cuminum cyminium* L.	.. Powdery mildew blight.	*Alternaria burnsii* ..	Leaf	.. Maharashtra	..
			Fusarium oxysporum ..	Young leaves	.. Maharashtra.	
3	*Foeniculum vulgare*	.. Mildew blight	.. *Laveillula teurica Cercospora foeniculi.*	Leaves.		
4	*Capsicum annum* ..	.. Leaf and fruit blight.	*Scelrotium rolfsii Diplodia, Alternaria* sp. virus and other diseases.	Leaves.		

6·5. Fruit Trees

TABLE No. II-12

Fungi Causing Diseases of Fruit Trees

Name (1)	Causal organism (2)	Part affected (3)
Cucurbit maxima	*Pseudoperonospora cubensis* ..	Leaf.
Citrus sinensis	*Phytophthora palmiyora* Butler. .	Stem, fruit leaves.
	Meliola citricola Syd.	Leaves.
	Diplodia indica Died	Bark.
Citrus sp.	*Rhynchodiplodia citri* Briosi and Farnetti.	Fruits.
Citrus chinensis	*Collectorichum gloeosporioides* Pensig.	Leaves, twigs.
Vitis vinifera L.	*Plasmopara viticola* Bark and Curt.	Leaves and fruits.
	Diaporthe viticola Nitis ..	Leaves and fruits.
	Eutypella vitis Ell. and Ev. ..	Wood of wine.
	Gloeosporium ampelophagum Sacc.	Stem, leave, berries.
Carica papaya	*Pythium aphanidermatum* .. Fitzpatrics.	Roots and fruits.
	Diplodia papayae Theum.	
	Macrophomina sp.	
	Rhizoctonia bataticola Ashby.	
	Gloeosporium papayae P. Heun.	Fruits.
Eugenia jambulana L. ..	*Capnodium eugenianum* ..	Leaves.
Cucumis sativum L. (Kakadi). ..	*Erysiphe polygoni* DC. ..	
Psidium guyava L.	*Meliola psidi* Fr.	Leaves.
	Physalospora psidii Stev and Peir *Uromyces fabae* De Bary.	Fruit, Leaves.
Mangifera indica L.	*Meliola mangifera* Earle ..	Leaves.
	Polyporus persooni Fr. .. .. *Botryodiplodia theobromae.* Patou. Mill.	Stem.
	Bagnisiella mangifera Tilak and R. Rao.	Twigs.
	Phyllosticta mortani Fair ..	Leaves.
	Gloeosporium raciboiskii .. P. Henn.	Fruits.
	Pestalotia funeria des Var. mangiferae Sacc.	Leaves.
	Rhinocladium corticolum ..	Bark.

TABLE No. II-12—*contd.*

Name (1)	Causal organism (2)	Part affected (3)
Fragaria vesca L.	*Mycosphaerella fragaroae* (Ful) Lind.	Leaves.
Aresa catechu L.	*Xylaria plebeja* Cesati	Roots.
	Colletotrichum catechu Diedicac. ..	
Cordia rothia Roem and Schutt.	*Aecidium brasiliensa* Dief ..	Leaves.
	Septoria cordiae Syd.	Leaves.
	Uromyces setariae-italica ..	Leaves.
Elaegnus latifolia	*Accidium elaegnilati foliae* Patch	Leaves.
	Endophyllum elaeugnitati-foliae	
Zizypus rugosa Lam. (Ber) ..	*Crossospora zizyphi* Syd. ..	Leaves.
	Oidium sp.	
	Cladasporium zizyphi Carst.	
Coffea arabica L	*Hemileia vestatrix* Berk. and Broome.	Leaves.
Gardenia gummifera L. ..	*Haplosporella gardeniae* .. Stems.	Leaves.
Ricinus communis L. ..	*Melamspora ricini* Pers ..	Leaves.
Phyllanthus emblica L. ..	*Phakopsora phyllanthi* Diet and Syd.	Leaves.
Vigana catjang Walp ..	*Uromyces appendiculatus* (Pers.) Linn.	Leaves.
	Corticium soloni Vourdotty and Galgin	
Gossypium sp	*Diplodia gossypina*	Old capsules.
	Diplodia manihotia Sacc. ..	Fruits and seeds.
Cymopsis tetragonoloba L. ..	*Phoma* sp.	
Artocarpus heterophyllus Lam	*Phyllosticta artocarpina* ..	Leaves.
Mimusops hexandra Roxb. ..	*Robillarda scutata* Syd. ..	Leaves.
Pyrus malus L.	*Scopella gentilis*	Leaves.
	Microsporinm sp.	
Musa sapientum L.	*Pestalotia leprogena* Speg.	
	Cladosporium sp.	
	Fusarium oxysoprum Schul.	
Citrullus vulgaris L. *Melo* ..	*Sclerotium rolfsii* Sacc.	

6·6. Diseases of Fruits in Storage

TABLE No. II-13

Fungi Causing Diseases of F.uits in Stoiage in Market

Name (1)	Disease (2)	Causal organism (3)
Annonaccae		
Annona squamosa L. (Sitaphal). ..	*Phytophthora* rot ..	*Phytophthora parasitica* Dast. Var. *macrospora* Ashby.
	Black rot	*Botryodiplodia theobromae* Pat.
	Charcoal rot ..	*Macrophomina phaseoli* (Maubl.) Ashby.
	Anthracnose ..	*Coll totrichum gloeosporioides* Peng.
	Black spot	*Pestalotia bicolor* Ell. and Ev.
Annona reticulata L. (Ramphal). ..	Black rot	*Botryodiplodia theobromae* Pat.
	Rhizopus rot	*Rhizopus nigricans* Ehrenb.
	Anthracnose ..	*Colletotrichum glcosporioides* Peng.
Garcinia indica choiss. D. C. (Ratamba).	..	*Pestalotia espellatii.*
Tiliaceae		
Grewia asiatica L. (Phalsa)	..	*Uredopeltis grewiae.*
Oxalidaceae		
Averhoa carambola L. (Karmak). ..	Aspergillus rot ..	*Aspergillus niger* Vantieh.
Citrus medica L. (Limbu) *acida.*	Citrus canker ..	*Xanthomonas citri* (Hasse). Dowson and Dowson.
	Waxy rot	*Geotricum candidum* Link.
	Leaf fall and fruit rot.	*Phytophthora palmivora* Butler.
Citrus sinensis (Musambi).	Osbeck fruit rot ..	*Gloeosporium citri Mass.*
	Black rot	*Alternaria citri* Pierac.
Citrus paradisi Macf. (grape fruit). Papas.	Decay	*Gloeosporium citri* and *Geotrichum candidum.*
Citrus reticulata Blanco ..	Decay	*Penicillium italicum* Wehmer, *digitatum* Sacc.
Feronia limonia Swingle (Wood-apple) ..	Diplodiadry rot ..	*Diplodia natalensis* Evans.
	Pink rot	*Trichothecium roseum* Link.
Aegle marmelos Corr (Belphal).		
Burseraceae		
Garuga pinnata Roxb. (Kakad).		
Rhamnaceae		
Zizyphus gujuba Lamk. (Bor). ..	Fusarium wilt ..	*Fusarium roseum* Link.

TABLE No. II-13—*contd.*

Name (1)	Disease (2)	Causal organism (3)
Vitaceae		
Vitis vinifera L. (grape) ..	Anthracnose ..	*Gloeosporium ampelophagum* de Bary Socc.
	Cladosporium rot	*Clodosporium herbarum* Link.
	Powdery mildew ..	*Uncinula necator* (Schw.) Burr. (Schw.) Burr.
Sapindaceae		
Nephalium longana Comp. Woomb.		
Litchi chinensis Sonn. (Litchi). ..	Black rot	*Aspergillus niger* var. Tieghi.
	Fruit rot	*Botryodiplodia theobromae* Pat.
Anacardiaceae		
Rhus mysurensis Heyne (Ambat).		
Mangifera indica (L) Mango	Sooty mould Black spot.	*Capnodium ramosum. Actinodochium jenkinsii* Upptal, Patel and Kamat.
	Black rot	*Asperigillus niger* Van Tiegh.
	Botryodiplodia rot	*Botryodiplodia theobromae.*
	Ripe rot	*Colletotrichum gloeosporioides* Peng.
	Cladosporium rot	*Cladosporium herbarum* (Pars.) Link.
	Corky spot ..	*Rhizopus nigricans* Ehr.
	Anthracnose ..	*Colletotrichum glocosporioides* Pengig.
Annacardium oxidentale L. (Kaju).	Fusariial rot ..	*Fusarium oxysporum* Scht. ex. Fr.
-emicarpus anacardium (Biba).		
Spondia mangifera Willa (Ambada).		
Rosaceae		
Pyrus matus L. (apple) ..	Scab	*Fusicladium deniriticum* (Wallr.) Fuckel.
	Soft rot	*Rhizopus nigricans* Ehr.
	Canker	*Sphaeropsis malorum* Pk.
Prunus arnieniaca L. (apricot). ..	Soft rot	*Rhizopus nigricans* Ehr.
	Black rot	*Memnoniella echinata* (Riv.) Gallow.
Ribes grossularia L. (Gooseberry). ..	Scurf	*Alternaria tenuis. Geotrichum candidum* Link.

TABLE No. II-13—*contd.*

Name (1)	Disease (2)	Causal organism (3)
Rubus sp. (Raspberry) ..	Soft decay ..	*Rhizopus nigricans* Ehr.
Prunus persica Sandz. (Peach).	Leaf curl	*Taphrina deformans* Berk and Tulh.
	Powdery mildew ..	*Sphaerotheca pannosa* (Wallr.) Lev.
Prunus domestica (L) (Plum)	Waxy rot	*Geotrichum candidum* Link.
Fragaria vesca (Strawberry)	Leaf spot	*Septoria aciculosa* Ell. and Ev.
Myrtaceae		
Psidium guava L	Phytophora rot ..	*Phytophthora parasitica* Dastur.
	Anthracnose ..	*Colletotrichum psidii.*
	Pink rot	*Trichothecium roseum* Link.
	Fruit canker ..	*Pestulotia psidii* Pat.
	Phoma rot	*Phoma psidii* P. Henn. Delacr.
	Ripe rot	*Gloeosporium psidii* Delacr.
	Waxy rot	*Geotrichum candidum* Link.
Eugenia corymbosa	..	Species of several fungi like *Pestalotia, Ciliochorella, Meliola,* etc.
E. jambolana (Jambul) ..		
E. malakensis		
E. jambos	..	*Capnodium eugenianum.*
Punicaceae		
Punica granatum L. .. .. (Dalimba).	Phomopsis Rot ..	*Phomopsis versoniana* Sacc.
	Black Rot	*Asperigillus niger* v. Tiegh.
	Bacterial leaf Spot	*Xanthomonas punicae.* Hingorani and Singh.
Onagraceae *Trapa bispinosa* Roxb. (Shingada). (Caricaceae). Passifloraceae (Cariaceae)		
Carica papuya L. .. .. (Papaya).	Ripe Rot	*Gloeosporium papayae* P. Henn..
	Phoma Rot ..	*Phoma caricae* Papayae A l.sch.
	Soft Rot	*Pythium aphanidermatum* (Eds) Figs.
Cucumis melo L. .. .. (Kharbus).	Phoma Rot ..	*Phoma citrullicola* Sawada.
	Charcoal Rot ..	*Macrophomina phaseoli* (Maubl). Ashby.
	Bitter core Rot ..	*Trichothecium oseum* Link.
	Pythium Rot ..	*Pythiuma aphanidermatum* (Edson) Fitg.
Citrullus vulgaris .. .. Scjr (Terbuse) or Water melon	Curvularia Rot ..	*Curvularia lunata* (Warker) Boedijn.

TABLE No. II-13—*contd.*

Name (1)	Disease (2)	Causal organism (3)
Trichosanthes palmata Roxb	Charcoal Rot ..	*Macrophomina phaseoli* (Maubl.) Ashby.
Kalingad	Dry Rot	*Bortyodiplodia* t·eobromae Pat.
	Pink Rot	*Trichothecium roseum* Link.
Rubiaceae		
Vanguria spinosa		
Vengueria roxberow		
Sapotaceae		
Achras sapota L (Chikoo) ..	Soft Rot ..	*Rhizopus rigr:cans* Ehrenb.
	Sooty mould ..	*Capnodium* sp.
	Leaf spots ..	*Phytopthora palmivora.*
Bassia latifolia Roxb. ..	Fusarial Rot ..	*Fusarium incarnatum* (Roberge) Sacc.
Oleaceae		
Olea europaca L. (Olive) ..	Peacock eye spot	*Cyclonium oleaginum* Cal.
Euphorbiaceae		
Phylanthus emblica L. .. (Avla).	Fruit blemish ..	*Ravenelia emblicae* Sydow.
Phylanthus distichus Muell (Rai Avala).		
Urticaceae		
Ficus carica L. (Fig) ..	Rhizopus Rot ..	*Rhizopus nigricans* Ehr. a virus.
	Mosaic disease.	
Artocarpus heterophyllus L... (Jack fruit or Phanas)	Leaf spot	*Colletotrichum lagenarium* (Pers) Ell and Holst.
	Stem Rot	*Phytophthora palmivara* Butler.
	Brown Rot ..	*Fomes noxius* Conner.
Artocarpus incisa L. .. (Bread fruit).	Black Rot ..	*Botryodiplodia theobromae* Pat.
Musaceae		
Musa paradisiaca L. .. (Banana).	Black Rot	*Gloeosporium musarum* Cke.
	Fusarium Rot ..	*Fusarium roseum* Link.
Bromaliaceae		
Annas comosus Merr. .. (Pine apple)	Black Rot	*Theilaviopsis paradoxa* V. Hoehnel.
Palmaceae		
Areca catechu L. .. .. (Arecanut or Supari).	Blemish disease ..	*Theilaviopsis paradoxa* V. Hoehnel.

7. Bacterial Diseases of Fruits and Vegetables

TALE No. II-14

Bacterial Diseases of Fruits and Leafy Vegetables

Name of the Plant (1)	Disease (2)	Casual organism (3)	Control and Remarks (4)
Sacchorum officinarum L ..	.. Red stipe of sugarcane	*Xanthomonos rubrilioneans* (Lee, et al) Starrand Burkh holder.	Burning diseased plants and building resistant variety.
Gossypium Sp.	.. Seedling blight angular leaf spot and black arm of cotton. ..	*Xanthomonas molvoceorum* (Dowson) E. F. Smith.	Building resistant varieties.
Solanum tuberosum L	.. Brown rot of	*Erwinia caroto vora* (Jones) Holland	Destruction of diseased tubers and putting them in chlorinated water.
Hibiscus esculentums	.. Leaf spot of Bhendi or Okra ..	*Xonthomonas esculanti* Rangaswami and Easwaran.	Roots are also affected by worms.
Allium sativum L	.. Seedling blight on onion	*Pseudomonas siccotum* (Moniz and Patel) Rangaswami.	..
Lycopersicum esculentum Mill and *Capsicum annum* L.	Leaf spot of tomato and chillies ..	*Xanthomonos vegicatoria* (Doibge) Dowson.	300 to 500 p. of Streptomycin spray 3 to 5 times.
All *Crucifers*	.. Black rot of Crucifers	*Xanthomonas campestris* (Pammel) Dowson.	1 pp. of mercuric chloride for 30 minutes effective.
Soft rot of vegetables, roots crops and bulbs.	.. ..	*Eyrwinia carotovora* (Johns) Holand	Wounding to be avoided.
Amaranthus viridis L	.. Leaf spot of *Amaranthus*	*Xanthomonas amaranthicolo* Patel et al.	..
Cucum is sativus L. Cucumber	.. Leaf spot of cucumber	*Xanthomonas cucurbitae* (Brayan) Dowson.	It also affects other cucurbitae *C. maxima. C. peto. C. moschato, C. vulgaris. C. sativus.*

TABLE No. II-14—*contd.*

(1)	(2)	(3)	(4)
Arum maculatum	Leaf spot of *Colacasia antiquorum* Schott.	A Species of Bacterium	..
Phaseolus sp.	Leaf spot and blight of beans	*Xanthomonas phaseoli* (E. F. sm.) Dowson.	Common on Pea, *Pisum vulgaris.*
Cicer arietinum L	Seedling rot and leaf blight of beans	*Xanthomonas cassiae* Kulkarni et al.	This is being seed borne disinfection of seed is essential.
Vigna cajang Walp	Blight of cowpea	*Xanthomonas vigni* cola Burk holders.	..
Cyamopsis tetragonoloba L. Taub	Leaf spot of cluster beans	*Xanthomonas cyamopsidis* Patel et al.	..
Cajanus cajan L. Millap	Leaf spot of Reg Gram or Pigeonpea	*Xanthomonas cajani* Kulkarni et al.	..
Glyscine max L. Merr	Leaf spot of soyabean	*Xanthomonas phaseoli* sojense (Hedges Dowson).	Dusting seed with sulphur.
Ricinus communis L	Leaf spot caster	*Xanthomonas ricini* cola (Elliott) Dowson.	..
Piper betle L	Leaf spots of Pan or betel	*Pseudomonas betle* (Raghunathan) Bergys et al.	..
Medicago sativa L	Leaf spot	*Xanthomonas alfa* alfae (Riber et al.) Dowson.	This bacterium can affect several other leafy legumes, plants such as *Pisum sativum Trigonella, Foenum grae* cum.
Citrus Sp.	Citrus canker	*Xanthomonas citri* (Hasse) Dowson.	..
Mangifera indica L	Leaf spot of Mango	*Pseudomonas mangiferae* indicae Patel et. al.	It also affects fruits.
Jasminum sambac Soland	Leaf spot of Jasmine	*Xanthomonas jasmini* Rangaswami and Eswaran.	..
Readish, cabbage, caulifloer etc. highly susceptible.	Black rot of cabbage	*Xanthomonas compestris* (Pamm.) Dows.	Prunning affected branches, and spray with Bordeaux mixture.
Oryza sativa L.	Bacterial blight of Paddy	*Xanthomonas oryzae*	New antibiotic Streptocyclene 0.3 gms in 100 lits twice or thrice should be sprayed.

8. List of Published Antibiotics Showing Antifungal Action

TABLE No. II-15

List of Published Antibiotics which show Antifungal Action

Organism (1)	Name of antibiotic (2)	Specificity of action (3)	Remarks (4)
1. *Streptomyces nowrsei*	Mystatin (Mycostatin)	Active against *Candia albicans Glocei-dioides immitis*, Blastomyces dermatitis.	Used successfully in treatment of moniliasis and also in coccidioi do mycosis and blastomycosis.
2. Streptomyces (From Pimpri soils)	Antifungal substance	Active against *Candida albicans Cryptococcous neoformans Histoplasma* sp. *Sporotrichum* Schenkii.	..
3. *Streptomycetes* sp.	Polynenes. Type— (1) Tetracne: Fungicidin Antimycosip Rimocidin Chromin. (2A) Pentaena: Amphotericin and fungi chromalip Eurocidin. (2B) Filipin Mediocidin. (3) Hexaene Flavacid. (4) Heptaena Ascosin, Candidocin Trichomycin Candimycin Amphotcricin B.	All these polyenic antibiotics show antifungal activity against yeasts and filamentous fungi like Aspergillus.	Amphotericina A and B have been used for treatment of disseminated coccidie desycosis.
4. *Bacillus subtilis*	Bacillomycin	Active against Apsergillis Penicillia and skin pathogens.	..

9. Diseases of Vegetables in Storage

TABLE No. II-16

Diseases of Vegetables in Storage in Market

Name of Vegetable (1)	Diseases (2)	Causal organism (3)
Amarantaceae		
Amarantus paniculata ..	Leaf spot and white rust.	*Alternaria amaranthii.*
Amarantus viridis L. ..	White rust	*Albugo bliti.*
Chenopodiaceae		
Beta vulgaris L. (Beet root). ..	Fusarium rot ..	*Fusarium oxysporum.*
	Leaf spot	*Cercospora beticola.*
Spinacia oleracea L. (Spinach). ..	Leaf spot	*Phyllosticta spinaciae* Lam.
Convolvulaceae		
Ipomoea batata Lam. ..	Rhizopus rot ..	*Rhizopus nigricans.*
	Soil rot	*Solerotium rolfsii.*
	Charcoal rot ..	*Macrophomina phaseoli.*
	Soft rot	*Rhizoctonia solani.*
	Black rot	*Ceratocystis fimbriata.*
	Leaf spot	*Cercospora timorensis.*
	Tuber rot	*Sclerotium rolfsii.*
	White rust	*Aspergillus* sp.
		Albugo ipomoeae
Compositae		
Lactuca sativa L.	Leaf spot	*Alternaria lactucae:*
		Cercospors longissima.
Cruciferae		
Brassica oleracea var. *capitata* L. ..	Black-leg disease	*Phoma lingam.*
	Black rot	*Xanthomonas campastris.*
		Alternaria brassicola.
Brassica leracea var. *botrytis* L.	Alternaria spot ..	*Alternaria brassicae.*
	Black spot	*Pestalotia brassicicola.*
	White rust	*Albugo candida.*
	Leaf spot and blight	*Alternaria brassicae.*
Brassica Oleracea var. *gongylodes* L.	White rust ..	*Albugo candida.*
	Leaf spot and blight	*Alternaria brassicae.*
Cucurbitaceae		
Citrullus vulgaris var. *fistulosus* stock (Tinda). ..	Fusarium rot ..	*Fusarium oxysporum.*
	Phoma rot	*Phoma cucurbitacearum.*
Coccinia indica	Anthracnose ..	*Colletotrichum lagenarium.*
	Black rot	*Alternaria tenuis.*
Cucumis melo var. *ultissimus* Roxb. (Dhendsi).	Anthracnose ..	*Colletotrichum.*
Luffa acutangula Roxb. ..	Black rot	*Macrophomina phaseoli.*
(Ridge ground) (Padval).	Soft rot	*Pythium aphanidermatum.*

TABLE No. II-16—*contd.*

Name of Vegetable (1)	Diseases (2)	Causal organism (3)
Luffa cylindrica L. Roem .. (Sponge ground or Ghosala).	Soil rot	*Macrophamina. phaseoli* and fruit rot due to *Fusarium oxysporum.*
Momordica charantia .. (Bitterground) L. or Karali.	Fusarium rot ..	*Fusarium oxysporum.*
	Soft rot	*Pythium aphanidermatum.*
Lagenaria leucantha Rusby (Bottle ground).	Black rot	*Botrydiploia theobromae.*
	Anthracnose ..	*Colletotrichum lagenarium.*
Cucumis sativus L. .. .. (Cucumber, kakdi).	Anthracnose ..	*Colletotrichum lagenarium.*
	Fusarium rot ..	*Fusarium roseum.*
	Soft rot	*Pythium aphanidermatum.:*
Schium edule Sw. .. .. (Chow-Chow).	Fusarium rot ..	*Fusarium oxysporum.*
Euphorbiaceae		
Emblica officinalis	Fruit blemish ..	*Ravenelia emblicae.*
Gramine		
Zea mays L. Maize or Corn	Blemish disease ..	*Alternaria tenuis, Curvularia lunata.*
Leguminosae		
Archis hypogae L. .. (Groundnut).	Dry rot of seeds and nut rot.	*Asperxgillus niger, Rhizoctonia bataticola. Curvularia lunata and Rhizopus nigricans.*
Cyamopsis tetragonoloba L. Taub. (Cluster beans).	Anthracnose ..	*Colletotrichum capsici.*
Dolichos lablab L. (Pavata)	Anthracnose ..	*Colletotrichum lindemuthlanum.*
	Cottony Leak ..	*Phytophthora parasitica.*
Phaseolus lunatus L. .. (Lima beans).	Anthracnose ..	*Colletotrichum capsici, Diplodia phaseolina.*
	Pod spots ..	*Alternaria tenuis, Curvularia lunata.*
Phaseolus vulgaris L. .. (French Bean).	Anthracnose ..	*Colletotrichum lindamuthianum.*
	Leak disease ..	*Phytophthora parasitica.*
Pisum sativum L. (Pea) ..	Anthracnose Leak	*Colletotrichum pisi Phytophthora parasitica.*
Trigonella focnumgraccum L. (Fenugteek, Methi).	Leaf spot	*Alternaria tenuis Cercospora traversiana.*
Vigna catijang var sinensis (Chavali).	Anthracnose ..	*Colletotrichum lindenuthianum.*
	Phoma fruit spot ..	*Phoma vignae.*
Liliaceae		
Allium cepa L. (Onion) ..	Black mould rot ..	*Aspergillus niger.*
	Bacterial soft rot ..	*Pseudomonas marginalis.*

TABLE No. II-16—*contd.*

Name of Vegetable (1)	Diseases (2)	Causal organism (3)
Allium sativum L. (Garlic) ..	Black mold rot ..	*Aspergillus niger.*
	Bacterial wet rot ..	*Erwinica carotovera.*
Malvaceae		
Hibiscus cannabinus L. (Ambadi) ..	Leaf spot	*Alternaria dianthi Cercospora hibiscina.*
Abelmoschus esculentus L. (Bhendi). ..	Fusarium rot ..	*Fusarium semitectum.*
	Leaf spot	*Cercospora malayensis and C. abelmoschi.*
Polygonaceae		
Rumex vesicarius L. (Chuka). ..	Leaf spot	*Phyllosticta acetosae* and *Cercospora* sp. *Peronospora rumicis.*
Rutaceac		
Murraya koenigii Spreng (Kadu limb).	Leaf spot	*Colletotrichum gloesporioides.*
Solanaceae		
Capsicum annum L. (Mirchi)	Anthracnose ..	*Colletotrichum capsici* (Syd) B. and B.
	Alternaria rot ..	*Alternaria tenuis.*
	Ripe rot	*Gloeosporium piperatum.*
	Black rot	*Rhizoctonia bataticola.*
	Phoma rot	*Phoma capsici.*
	Fruit spot	*Bipolaris tetramera.*
	Phytophthora rot ..	*Phytophthora parasitica.*
Lycopersicum esculentum Mill. (Tomato). ..	Alternaria rot ..	*Alternaria solani.*
	Soft rot	*Phytophthora parasitica.*
	Phoma rot	*Phoma destructiva.*
	Anthracnose ..	*Colletotrichum phomoides.*
	Waxy rot	*Geotrichum candidum.*
	Cladosporium rot	*Cladosporium fulvum.*
Solanum melongena (Brinjal)	Alternaria rot ..	*Alternaria tenuis.*
	Phomopsis rot ..	*Phomopsis verans.*
Solanum tuberosum L. (Potato). ..	Ring rot	*Pseudomonas solanacearum.*
	Dry rot	*Fusarium trichothecioides* and *F. caeruleum.*

10. FUNGI ON MEDICINAL PLANTS

TABLE No. II-17

Fungi on Medicinal Plants in Maharashtra

Serial No. (1)	Name of the Host (2)	Causal organism (3)	Parts affected (4)	Distribution (5)
I.	Family Nymphyaceae	Fungus		
1	*Nelumbium speciosum*	*Physoderma narasimhanii* Thirum and Pacgi.	Leaves	Pune, Karad.
2	*Nelumbium speciosum*	*Physoderma nelumbi* De Bary	..	Nasik.
II.	Family Cruciferae			
3	*Brassica juncea*	*Alternaria brassicae* (Berk) Sacc.	Leaves	Pune.
III.	Family Rutaceae			
4	*Citrus aurantifolia*	*Phytophthora palmivora*	Plant	General distribution.
IV.	Family Anacardiaceae			
5	*Anacardium occidentale*	*Phytophthora palmivora*	Fruit rot	General distribution.
V.	Family Leguminoceae			
6	*Pongamia pinnata*	*Chaetothyrium mundkurii* Tilak	Plant	Khandala.
		Phyllachora pongamiae (Berk and Br.) P. Henn.	Leaves	Pune.
7	*Cassia fistula*	*Diatrypella cassiae Tilak*	Twigs	Aurangabad.
8	*Cassia fistula*	*Dothiella cassiae* Tilak	Stems	Aurangabad.
9	*Pongamia pinnata*	*Ravenelia hobsonii* Cooke	Leaves	Pune, Khandala, Vita near Karad.

TABLE No. II-17—*contd.*

Serial No. (1)	Name of the Host (2)	Causal organism (3)	Parts affected (4)	Distribution (5)
VI.	Family Caesalpineae			
10	*Cassia siamea*	*Cercospora cassiaesiameae* Chid.	Leaves	Pune.
	Cassia tora	*Cercospora cassiocarpa* Chipp.	Leaves	Pune.
VII.	Family Mimosae			
11	*Albizzia lebbek*	*Ravenelia sessilis* Berk	..	Aurangabad, Pavnar, Nagpur.
12	*Albizzia procera*	*Circinotrichum maculiformae* Nees ex Persoon		
VIII.	Umbelliferae			
13	*Hydrocotyle asiatica*	*Cercospora hydrocotyles* Ell. et Ev.	Leaves	Pune.
IX.	Family Apocynaceae			
14	*Nerium odorum*	*Cercospora neriella* Sacc.	Leaves	Pune.
X.	Family Acanthaceae			
15	*Leptadinia reticulata*	*Cercospora leptadeniae*	Leaves	..
XI.	Family Pieraceae			
16	*Piper betel*	*Capnodium betelei* Syd. and Butler	Leaves	General distribution.
XII.	Family Euphorbiaceae			
17	*Ricinus communis*	*Phytophthora parasitica* Hesse.	Plant	Khandala.
XIII	Family Dioscoriaceae			
18	*Dioscorea* sp.	*Cercospora carbonacea* Miles	Leaves	Khopoli.
XIV.	Family Liliaceae			
19	*Aloe vera*	*Uromyces aloeae* Magnus	Leaves	Pune, Aurangabad

11. Fungi on Ornamental Plants

TABLE No. II-18

Fungi on Ornamental Plants in Maharashtra

Serial No. (1)	Host (2)	Causal organism (3)	Parts affected (4)	Distribution (5)
1	Family Magnoliaceae	*Pestalolia micheliae Kalani*	Leaves	Katraj-Pune.
2	*Michelia champaca*	*Phyllostricta michelicola* Vasant Rao	Leaves	Pune.
		Rabillorda trichetrae Vasant Rao	Leaves	Pune.
	Magnolia sp.	*Phyllosticta magnoliae* Sacc.	Leaves	Pune.
3	Nymphyaceae *Nelumbium speciosum*	*Physoderma nelumbi* Mishra and Thomn	Leaves	Pimpri, Pune.
		Alternaria tenuis Auct	Leaves	Aurangabad.
	Nymphaea speciosa:	*Ramularia nymphaeorum* (All.) Rem.	Leaves	..
4	Family Crucifereae *Brassica juncea*	*Alternaria brassicae* (Bark) Sacc.	Leaves Petiole	Khed.
5	Family Leguminosae (Papillionaceae) *Pongamia glabra*	*Ravenelia hobsonii Cooke*	Leaves	Pune, Khandala, Vita near Karad.
6	Family Mimosae *Albizzia lebbek*	*Ravenelia sessilis Berk*	Leaves	Pune.
	Albizzia procera	*Circinotricum maculiformae* Nees ex Persoon	..	

TABLE No II-18—*contd.*

(1)	(2)	(3)	(4)	(5)
7	Family Caesalpinaceae			
	Cassia siamea	*Cercospora cassiae* Child.	Leaves	Pune.
	Cassia tora	*Cercospora cassiocarpa* Chipp.	Leaves	Pune.
	Cassia nodosa	*Sphaerulina trifolia* Rost	Leaves	Aurangabad.
	Cassia medica (*C. sophora*)	*Mycosphaerella cassiae* Tilak		
	Bauhia Vahlii	*Phyllachora bauhiniae* (Wint) Thiss. ex Sydow.	..	..
8	Family Rosaceae			
	Rosa sp.	*Phyllosticta rosae*	Leaves	
9	Family Lythraceae			
	Lagerstroemia parviflora	*Cercospora lathracearum* Heald Werf	..	Khandala.
	Lagerstroemia lanceolata	*Cercospora lathracearum* var. *macrospora* Child.		Pune.
10	Begoniaceae			
	Begonia species	*Alternaria tenuis* var. *rosicola*	..	..
11	Umbelliferae			
	Hydrocotyle asiatica	*Cercospora* hydrocotyles Ell. et. Er.	Leaves	Pune.
12	Araliaceae			
	Aralia chinensis	*Alternaria araliae*		
13	Rubiaceae			
	Ixora drachiata	*Phyllosticta ixorae* Hangel.	Leaves	Pune.
		Robillardia sessibis Sacc.	Leaves	Pune.

14	Family Compositeae			
	Zinnia elegans	*Choanephora simsonii* Cunn.	Flowers	Pune.
	Cosmos bipinnatus	*Acrosporium* sp.		General.
		Sphaerotheca fuliginosa (Schl)	Leaves	
	Chrysanthemum indicum	*Alternaria casotiniana Unam*:	Leaves	Pune.
		Alternaria chrysanthemi T. Sch.	Leaves	Pune.
		Alternaria tenuis Auct.	Leaves	Pune.
		Acrosporium sp.	Leaves	General distribution, Aurangabad.
		Phyllosticta chrysanthema Heald and Wolf.		Pune.
	Helianthus annus:	*Puccinia helianthi* Schw	Leaves	Kolhapur.
		Alternaria tenuis		
	Dahlia variabilis	*Acrosporium* sp.	Leaves	General distribution.
	Gerbera jacksonii Bdus	*Alternaria brassicola* (Schw) Wiltshire	Leaves	Pune.
	Zinnia elegans	*Alternaria zinniae Papc.*	Leaves	General distribution.
		Cercaspora zinniae Ella and Mart	Leaves	Pune.
		Phyllosticta zinniae P. Brun.	Leaves	Pune.
	Chrysanthemum sp.	*Cercospora chrysanthemi* Herald	Leaves	General distribution. Pune.
	Cosmos bipinnatus	*Cercospora cosmi* Chidd.	Leaves	Pune.
	Dahlia sp.	*Cercospora granulissima* Rangel	Leaves	Bhusaval and Pune.
15	Family Oleasceae			
	Olea dioica	*Colletorichum* olae (Butler) Cummins	Leaves	Amba Ghat.
16	Family Apocynaceae			
	Nerium odorum	*Cercospora neriella* Sacc.	Leaves	Pune.
	Allamanda cathartica	*Chaetosphaeria poonensis* Kalani	Twigs	Pune.
17	Family Convolvulaceae			
	Ipomoea palmata	*Botryosporium indicum* Tilak	Branches	Aurangabad.
	Ipomoea hederaceae	*Cercospora ipomoea* Winter	Leaves	Pune.
	Ipomoea illustris	*Cercospora ipomoeae* var. *illustriae* Chidd.	Leaves	Pune.

TABLE No. II-18—*contd.*

(1)	(2)	(3)	(4)	(5)
18	Family Asclapiadaceae *Leptadenia reticulata*	*Cercospora leptadeniae* Child	Leaves	Pune.
19	Family Nyctaginaceae *Bougainvillea spetabilis*	*Amphispheria gymnosporiae* V. Rao *Hysterium tamarindii* Tilak	Stem	
20	*Euphorbiaceae*	*Phyllosticta bryosiana*	Leaves	Aurangabad.
	Scalypla sp.	Acalypha.	Leaves	Pune.
	Euphorbia geniculata	*Oidiopsis* sp.	Leaves	Aurangabad.
		Phyllosticta crotoniphila Zoeg.	Leaves	Pune.
21	Scitaminaceae *Musa sapientum*	*Fusarium oxysporium*		
22	Liliaceae *Aloe vera*	*Uromyces aloes* Magnus		
23	Amaryllidaceae *Crinum* sp.	*Phyllosticta criniola* Ziemaszko	Leaves	Pune.
	Canna indica	*Phyllosticta cannicola* V. G. Rao	Leaves	Pune.
24	Iridaceae *Gladiolus*	*Phyllostica gladiocides* Butista	Leaves	Pune.
25	Dioscroreaceae *Dioscorea*	*Cercospora carbonacea* Milas	Leaves	Khopoli.
26	Pandanaceae *Pandanus sp.*	*Phomopsis pandani* Died.	Leaves.	

12. Diseases of Forest Trees and Leaf Litter Fungi :

Many wild plants are attacked by fungi, providing hosts for various fungal diseases which spread to economic plants also. The most important fungi on the principal forest trees are given here. For control measures, works on Forests mycology can be consulted. The most important product of Maharashtra forests is timber which is very often left in field and in stalks in open and gets attacked by Fungi Imperfecti or mushrooms and Polypores. There is need of much work on them than it has been done at present. It is well-known that the most important timber tree of Maharashtra is *Tectona grandis*. It is affected to a large extent in winter months by *Uncinula tectoniae* which causes heavy damage to timber as well as tree.

However, when the forest tree leaves fall to the ground they improve the texture and fertility of the forest soil by rotting the debris fallen on the ground. In this process of soil building and improvement the leaf litter fungi like *Circinotrium*, *Beltrania* and other Hyphomycetes are very important as they are found practically on all rotten leaves on floor in a dense forest. Some fungi, particularly species of *Fusaria*, attack roots of Conifers and Rosaceae. They have symbiotic fungi, mycorrhiza, in them. It greatly helps them in mineral nutrition although it must be noted that coniferous forest do not exist in the tropical and sub-tropical climate of Maharashtra. They occur in *Pygium gardeneri* above 5000′. In the past however, there were areas where members of the Rosaceae were there as is evident from the fossils of Rosaceae found in the Deccan Intertrappean beds. Many grass roots are also affected by mycorrhiza due to genus *Rhizoctonia* or *Fusarium*. Like forest trees, fungi also attack garden plants and medicinal plants. A garden is an artificial area where selected plants are cultivated, often exotic or from other places. They fall victim to fungi. A forest on the other hand, is natural growth of vegetation, and only partly cultivated by introducing new species. It is, therefore, mostly natural and only partly cultivated. Along with the cultivated plants come fungi and viruses. The same thing is true of ornamental plants and medicinal plants. There are very few gardens of drug yielding plants. Most of them are collected from their natural habitat by plant collectors. The cultivation of drug yielding plants is done in the gardens of medicinal plants at Jammu and Shrinagar. In this State at Pune, there is the Jawaharlal Nehru Udyan or garden of Ayurvedic medicinal plants.

The diseases on medicinal plants need greater attention as they affect the photosynthetic activity of hosts and their products. A large number of leaf spot fungi are present on them. Since many drugs are extracted from leaves, bark and roots of medicinal plants which are stored in non-airconditioned rooms, they get heated up, and are used as such by the pharmacists, without examining pathogens on them. It is highly desirable, therefore, that diseases of these plants are known to pharmaceutical works, so that they can avoid use of diseased parts. (*See* Table II-17, pp.-191-92).

12·1. Diseases of Forest Trees

TABLE No. II-19

Diseases of Forest Trees

Name (1)	Causal Organism (2)	Parts affected (3)
Cassia fistula	*Diatrypalla cassiae* Tilak ..	Twigs.
	Dothiella cassiae Tilak ..	Twigs.
	Phyllactinia corylea (Pers) Karst.	Twigs.
Cassia tora	*Diaporthe* sp.	Stem.
Emblica officinalis	*Aspergillus niger* V. Tiegh.	
Hardwickia binata Roxb. ..	*Fusarium* sp.	Root, Stem.
	Circinotrichum maculaeformae Nees ex Pers.	Leaves.
Acacia arabica	*Calosphaeria acaciae* Kale ..	Stem.
	Diatrypa acaciae Tilak ..	Stem.
	Phyllactinia acaciae Syd ..	Leaves.
	Sphaerostilbe acaciae Tilak ..	Branch.
	Cytospora acaciae Tilak and Roek.	Stem.
	Diplodia acaciae Tilak and Rokde.	Stem.
	Fusicoccum indicum Tilak and Rokde.	Stem.
	Haplosporella acaciae Tilak and Rao.	Stem.
Acacia catechu	*Erysiphe acaciae* Blumer. ..	Pods.
	Collectotrichum catechu Died ..	
Terminalia chebula	*Phyllactinia terminaliae* Ramk..	Leaves.
	Masseela terminaliae .. Patwardhan.	Leaves.
	Cercospora catappae P. Henn.	Leaves.
Terminalia tomentosa ..	*Phyllactinia terminaliae* Ramk. *Clavaria* sp.	Leaves.
Bambusa nana	*Ascochyta bambusinae* Vasant Rao.	Leaves.
Ficus glomerata	*Capnodium anonae* Pat. ..	Twigs.
	Cerotelium fici (Butler) Arthur	
	Phyllosticta ficicola Pat. ..	Leaves.
Aegle marmelos Core ..	*Acrosporium* sp. (Oidium Link)	Leaves.
Lagerstroemia flos-reginae ..	*Ciliochorella mangiferae sydow*	Leaves.
	Lophodermium indicum Tilak ..	Leaves.
Lagerstroemia lanceolata ..	*Cercosporalythracearum* var. *macrophora* Chiddarwar.	Leaves.
Thespeshi populnea	*Septoria thespesiae* Ramakri Tis.	Leaves.

TABLE No. II-19—*contd.*

Name (1)	Causal organism (2)	Parts affected (3)
Eucalyptus globulus ..	.. *Beltrania rhombica* O. Renzig	
	Circinotrichum maculaeformae Nees	
	Monochaetia syringae (Oud) Allech.	Leaves.
	Pestalotia dissiminata Theum ..	Leaves.
	Ciliochoreiia eucalypti Viswanathan.	Stem.
	Phyllosticta eucalypti Thuem ..	Leaves.
Grewia asiatica ..	.. *Uredopeltis grewiae* (Cummins) Sath.	Leaves.
Allanthus excelsa ..	.. *Cercospora ailanthicola* Patwardhan. ..	Stem.
Madhuca latifolia Roxb. (Bassia latifolia).	.. *Scopella echinulata* (Niessl.) Mains. ..	
	Uromyces echinulatus Niessl.	
Morus alba	.. *Mycosphaerella indica* Viswanathan. ..	Leaves.
	Phyllactinia corylea (Pers) Karst.	
	Ceroteliumfici (Butler) Arthur.	
Salmaila malabarica	.. *Diatrype salmaliae* Tilak ..	Stem.
	Haplosporella. Spp.	
	salmaliae Tilak and Rao ..	Stem.
Dalbergia sissoo ..	.. *Phyllactinia yarwoodii* Patwardhan. ..	Leaves.
	Uredo sissoo Syd and Butler.	
	Colletotrichum gloeosporInides Penz	Leaves and twigs.
Dalbergia latifolia ..	.. *Cercospora dalbergiae-latifoliae* Chiddarwar.	Leaves.
Tamarindus indica ..	.. *Phyllosticta tamarindilcola* V. Rao.	Leaves.
Eugenia jambolana ..	.. *Plaglostigme deodikorii* Ananth.	Leaves.
	Circinotrichum maculaeformae Nees ex Pers.	Leaves.
	Pestalotia carrisae Guba ..	Leaves.
	Pestalotia eugeniae Thuem ..	Leaves.
	Selenophoma kamatii Kalani ..	Leaves.
Tectona grandis L. ..	.. *Auricularia mesenterica* Br.	
	Uncinula tectonae Chaconia tectoniae Ramkrishnan T.S.K. Ramkrishnan.	Leaves.
	Cerocospora tectoniae Stevens.	

13. Regional Wheat Rust Research Station Mahabaleshwar ;

The wheat crop is cultivated in Maharashtra mainly in *Rabi* season. The species grown is *Triticum vulgare* or what is known as soft wheat. The wheat plant is attacked by many plant pathogens, the most destructive among them causing loss in yield are the rusts. Earliest record of rust epidemic was in 1927 in Central Provinces. It reappeared in 1939, and in a severe form in 1946-47, in parts of Maharashtra, Madhya Pradesh and Rajasthan. Two million tonnes of wheat was supposed to have been destroyed by it. In order to investigate causes of such huge losses, a Regional Wheat Rust Research Station was established at Mahabaleshwar for determining the resistant varieties of wheat generally cultivated. and for testing the resistance of newly bred varieties. There are three rusts associated with the wheat crop in India.

1. Stem rust or Black rust due to *Puccinia graminis tritici.*

2. Leaf-rust or Leaf brown rust due to *Puccinia recondita* and

3. Stripe or Yellow rust due to *Puccinia striiformis.*

These three rusts are distributed in our country in definite pattern.

The stem rust *Puccinia graminis tritici* occurs in more severe form in Peninsular and Eastern India, though it does occur in all parts of India here and there.

Brown rust occurs all over India and can occur in any part of the country.

In Maharashtra, yellow rust has not been observed but only stem and leaf rust are known to occur. The stem rust occurs in Maharashtra and is more destructive than leaf rust. Stem rust can infect wheat crop at any stage, producing oblong brown dusky pustules in any given parts stem, leaf, sheath. The pustules enlarge, fuse and form big lesions, containing thousands of Urbedospores. At maturity they turn black and plants shrivel. The grains get shrunk and yield goes down. The infected plants have a tendency to lodge. The infection is spread by wind. It comes from adjoining fields. The rust remains on self sown wheat plants in fields throughout the year in the hills of Peninsular India, Nilgiris, due to low temperature and humidity. As the new crop starts growing the spores from the lodged plants in the hills remain dormant. With early rains they start germinating and enter through stomata of young plants and form mycelia. They form single celled Uredospores. The spore mass increases and leaf epidermis ruptures. The initial infection gives rise to new uredospores and spreads infection to entire new green crop. Then the double celled teleutospores are formed but they are functionless and the life cycle is not complete, due to the unavailability of basidiospores, pycniospores and aeciospores.

There are about 23 physiological races so far recorded in India as stem rust, namely 11, 14, 15c, 17, 21, 21-A, 24, 34, 34-A_1, 40, 40-A, 42, 42-B, 42-B_2, 43-B_3, 117, 117-A, 122, 184, 194 and 295. Out of these 11, 15-c, 21-A, 40-A, 42-B_2, and 122 are considered very virulent races. RA.E 17, 21 commonly occur on stem in Maharashtra. In recent years race 117-A, has been occurring with high frequency generally in second fortnight of January when temperature is low, humidity high and no or scanty rainfall.

Leaf or Brown Rust :

This also occurs throughout the country either in isolated or epidemic form. It is very much destructive in Northern India. In Maharashtra it is less damaging than the stem rust. It appears before the stem rust in Maharashtra generally in December. It has so far 15 physiological known races namely 10, 11, 12, 17, 20, 63, 77, 77-A, 77-B, 104, 106, 107, 108, 162 and 162-A. Of these races 12, 77-A, 71-B, 162-A are considered virulent. In Maharashtra races 77 and its biotypes and 162-A are seen in nature every year. Most of the cultivated varieties of wheat in Maharashtra are susceptible to leaf rust races. Hence leaf rust infection is often seen on races released for cultivation. However, it was also seen that varieties U. P. 125, HD-4502, Malavika, HD-2189 are resistant to leaf rust.

The best method to control rust is to grow rust resistant wheat varieties. In Maharashtra, Kalyan-Sona, Sonalika, NI-5439, NI-5643, UP-215, HD-4502, HD-2189, CC-464 are generally recommended for growing. Of these UP-215 and HD-2189 are resistant to both stem and leaf rust.

To determine the resistance of wheat varieties, the mature plants of released varieties are artificially grown under epiphytic conditions for rust. They are as follows :—

Serial No.	Variety	Stem rust infection	Leaf rust infection
(1)	(2)	(3)	(4)
1	Kalyan-sona	80%	80%
2	Sonalika	30%	80%
3	NI-747-19	80%	80%
4	NI-5439	80%	80%
5	NI-5643	40%	60%
6	HD-4502	40%	R
7	UP-215	R	R
8	CC-464	R	40%
9	HD-2189	R	R
10	HY-65	80%	80%
	Dry wheat		
11	N-59	80%	80%
12	MACS-9	80%	80%
13	N-5749	80%	80%

Another way of controlling rust is chemical method using fungicides. It is said to be less effective as the spraying of fungicide has to be done throughout the growing period at an interval of 15 days. Crop if irrigated, then spraying of Zinc or Manganese Thio-carbonate 02% has to be undertaken immediately after the first pustules appear on the crop and then second, third etc. have to be given at the interval of 15 days. Therefore to breed and test rust resistance in varieties the tests are carried out on experimental farm.

WORK BEING CARRIED OUT AT THE REGIONAL RUST RESEARCH STATION, MAHABALESHWAR

1. Maintenance of 23 races of stem rust and 15 races of leaf rust. They are being maintained in live form on NP-4 and Moha varieties which are maintained throughout the year.

2. Differential wheat variety for finding out rust races of stem rust are :—

(1) Little club, (2) Marquis, (3) Reliance, (4) Kota, (5) Arnautka, (6) Mindum, (7) Spelmar, (8) Kubanka, (9) Acme, (10) Einkorn, (11) Vernal, (12) Khapli.

Leaf rust differentials :

(1) Malakof, (2) Hussar, (3) Mediterran, (4) Democrat, (5) Carina (6) Brevit, (7) Webster, (8) Loros.

The infection types are produced by physiologic races of stem rust on differential varieties.

1. Immune varieties do not form uredia. They are very resistant varieties and have minute uredia surrounded by chloratic or necrotic areas. Very susceptible ones have large and coalescing but no necrosis. Occasionally only chlorosis. Moderately susceptible varieties develop small or medium sized uredia as green islands. They often coalesce but have no necrosis.

In heterogenous varieties all types of infections appear on the leaves. From experience it can be stated that infection resistant types are 0, 1, 2 and susceptible types are 3 and 4.

(2) Second important work is being done.—Testing of resistance of fixed varieties. Each year 100-200 varieties are tested at the seedling stage.

(3) To make resistant varieties available to breeder as donor parents.

(4) Resistance of fixed varieties is also tested. Some of the resistant varieties are as follows :—

(1) E 8667, (2) CPAN 1283, 1885, (3) CPN 1360, 1418, 1436, 1441, (4) Hybrid cultures of F_3-F_6 generation numbering 10,000, are screened against the rust disease under artificial epiphytic condition. Seed of resistant plants of each generation are selected and on the basis of such vigorous testing are evolved resistant wheat variety for each of the following States.

Maharashtra, Madhya Pradesh, Gujarat Karnatak and Andhra Pradesh.

The following varieties are rust resistant for Maharashtra :—

(1) N-59, (2) NI 146, (3) N-I-284/5, (4) NI-917, (5) N-5749, (6) MACS-9.

Varieties of other states are different and they are also tested for rust resistance and recommended for cultivation.

(5) *Study of Race Flora* :

This station maintained rust trap nurseries at 20 different places in different agro-climatic zones. By study of the performance of released varieties and their strains more promising strains are sorted out. The rust trap nurseries have proved to be useful in analysis of different samples. Their cultivation is also done for detecting the physiological races.

It has been recently found that Race 147-B-1 of stem rust has started occurring with greater frequency in recent years.

The main utility of this station lies in recommending particular wheat rust resistant varieties to a particular region. Of late it also has started work on rust on groundnut, jowar and bajra.

The above information was furnished by Shri S. K. Ruikar, Mycologist-in-Charge of the Regional Wheat Rust Station, Mahabaleshwar and by Dr. Y. S. Kulkarni, who was previous in charge of it.

14. Bacterial Plant Diseases in India

(G. Rangaswami 1962 and other works may be cited here as authentic)

There are many bacterial plant diseases like fungal diseases of plants. Their study however on agricultural plants started with Erwin, F. Smith of U. S. Department of Agriculture in 1890, and now many of them are known. They were classified under Protophyta by Sachs and their classification has been reformed by Russian Bacteriologist Krassinikov (1949). He makes 10 Orders.

Classification of Bacteria by Krassinikov (1949)

Class Schizophyceae (Cohn, 1879) or Schizomycetes Microtabiomycetes (Naegeli 1857, Philip, 1955)

Fission algae :

Order I. Pseudemonadales Rickettsides (Orla. jensen, 1921, Buch. e. Buch 1958).

II. Hyphomicrobiales (Douglao, 1956) (Breed, et al. 1944) Virales.

III. Chlamydobacteriales (Buchanan, 1917).

IV. Eubacteriales (Buchanan, 1917).

V. Actinomycetales (Buchanan, 1917).

VI. Caryophanales (Peshkaff, 1940).

VII. Beggiatoales (Buchanan, 1956).

VIII. Mexobacterales (Jhon, 1911).

IX. Spirochectales (Buchanan, 1918).

X. Mycoplasmatales (Preundt, 1955).

The sub-order Pseudomonadineae consists of seven families as detailed below :—

I. Nitrobacteraceae-Oxidises ammonia to nitrates and nitriles to nitrates, autotrophic.

II. Methanomonadaceae—Oxidises methane to hydrogen and carbon monoxide, autotrophic.

III. Thiobacteriaceae—Oxidises sulphur compounds.

IV. Pseudomonadaceae—Frequently oxidative, sometimes fermentative, heterotrophic or facultative autotrophic.

V. Caulobacteraceae—cells attached to the substrate by means of a slack.

VI. Siderocapsaceae—Cells free floating or attached to the substrate by means of capsular material.

VII. Spirillaceae—Cells vibrio-like to spiral.

Of these, Pseudomonadales, Eubacteriales and Actinomycetales are of great importance for the economic plants. Pseudomonials are important autotrophic bacteria oxidizing ammonia to nitrites and then into nitrates, Methane etc. *Methano-bacterium* reduces carbon-dioxide to methane. Sub-order Rhodobacteriineae contains photosynthetic types. Eubacteriales are simple undifferentiated cells, rod-shaped or round. They are mostly soil dwellers and fix free nitrogen in Leguminous plants. They are heterotrophic and form root nodules. Some of them ferment glucose anaerobically. Their shapes are varied. As soil bacteria they are very important. Some of them are facultative anaerobic and some are aerobic. The family Bacillaceae has only two genera, but many species.

Bacillus :—25, and *Clostridium*-93 species which are agriculturally all important.

Actinomycetales has four families, some of them have septate or aseptate mycelium. Actinomycetaceae forms spores by fragmentation of mycelium and Actinoplanaceae forms spores in sporangia; other two families Mycobacteriaceae and Streptomycetaceae do not form spores.

Bacteria are the lowest forms of Thallophyta, and are also known as Schizomycetes. They are unicellular, without nucleus and chlorophyll. They reproduce by fission or linear division. They lead a saprophytic or parasitic existence. Many of them are pathogenic, causing diseases to man, animals and plants. Some of them are common to man as well as animals e.g., Bacillus of Anthrax. They feed on very simple substances in solution. They have "holophytic nutrition". They are supposed to be a connecting link between plant and animal world.

Another group of organisms similarly living on plants, animals and man are viruses which are more virulent than bacteria because viruses can live only on living organisms. They also cause many plant and human diseases. A new group of similar organisms, now reorganised only in recent years, is called *Mycoplasma*, supposed to be intermediate between Virus and Fungi. Their characterisation and details of metabolic requirements are not yet fully known.

There are six types of plant diseases :—

1. Those due to Bacteria or Schizomycetes.
2. Those due to Fungi.
3. Those due to Viruses.
4. Those due to worms and other animal parasites
5. Those due to plant parasites.
6. Deficiency diseases.

Many large treatises have been written on symptoms, etiology, spread and control of them, but that is outside the scope of this work, therefore, only important plant diseases will be dealt here with in a general way. Deficiency diseases are not uncommon due to want of some component of food or minerals, or their salt required for the proper metabolic processes. Die-Back of *Citrus* on *santra* or *mosambi* in Ahmadnagar and other districts, is supposed to be due to mineral deficiency of *calcium* and potassium. Band disease due to copper deficiency is believed to be responsible for the death of coconut trees in Konkan. Molybdenumm deficiency causes death of many fruit trees etc. They are the examples of such diseases and are difficult to treat or eradicate.

A lot of work on bacterial diseases of economic plants has been done in our State by M. N. Patel, V. P. Bhide, Y. S. Kulkarni and Monizt (1951); some of it is of great significance in plant pathology. It is nor possible to describe here either the symptoms or control measures foe bacterial diseases or other plant diseases. A few of them which are important from the view point of useful plants in this State are listed The bacterial diseases of plants commonly found in Maharashtra are given in Table No. II-14 pp. 185-186.

15. Viral Diseases

Many viral diseases which affect the plant are highly infectious. Due to them the leaves, their veins, become yellow, form curly top mosaic rosettes, bunchy top; their veins get streaked out: Ringspot, dwarfing, blisters, formation of small leaves, hairy root, curling of leaf margins are the common symptoms. They seldom kill the plant, but seriously affect the growth and yield. They are supposed to be transmitted by insect vectors. *Papaya mosaic*, little leaf disease of *brinjals*, bunchy to p of *banana*, *Katte* or Marble disease, yellow vein mosaic of *Hibiscus esculentum* (Bhendi), curling of tobacco leaves, various species of bean leaves are some examples of common viral diseases in Maharashtra.

16. Other Diseases Due to Worms and Flowering Parasites

Some diseases of underground roots, tubers and rhizome are due to a variety of Nematodes. "Cocle" disease of wheat, root nodes of potato, brinjal, tomato, tobacco, piper, onion, soya-bean, *Gladiolus*, *Solanum* species quite often have the roots affected by the growth of worms. Moderate or low range of temperature and non-sterilised soil or soil contaminated by worms are the chief source of infection. Long rotation and keeping soil fallow for two-three years, fumigation are some of the control measures. Cocle disease of wheat comes from infected areas. If that is avoided and soil washed with salt water, the disease disappears

Angiospermic Parasites :

These are of two types : Those have green leaves and can undergo photosynthesis, and those without Chlorophyll or green leaves. They have no ability for carbon assimilation.

Loranthus and *Viscum* are the examples of semi-parasites or green parasites, whereas *Cuscuta* or *Cassytha*—a member of the Laurauae are examples of the other kind. The latter suck manufactured food from the host plants with their special suctorial organs 'the haustoria'. There are some serious root parasites growing on tobacco, jowar etc., such as (1) *Broom rape* or *Orobanche*—It also hosts on the roots of tobacco, brinjal, tomato and other Solanaceous plants. They are highly destructive. (2) *Striga*—Different species of *Striga* grow on the roots of sorghum or jowar, sugarcane etc. Spraying 5 ppm 2, 4 D helps a little but not much in eradication.

Besides these, there are other flowering parasites, but they are on wild plants, e.g. *Aeginetia* on roots of *Euphorbia* and other bushes, *Christiansonia* on *Strobilanthes*, *Lantana camara*, etc. *Cistanche tubulosa* grows on *Salvadora persica* and *S. oleosa*. But these will be considered separately under Parasitic plants. *Cistanche* is not so far known in Maharashtra.

17. Mushrooms

Edible and incdible.—The layman's notion that fungi are harmful and have no value as food is not entirely correct, as some fungi like yeast and mushrooms and agarics are edible. 'Mycos' or 'Mykes' originally means mushrooms. Some of these are edible and others poisonous; some others are not poisonous but also are not edible. Bose (1940) has described edible mushrooms of India. Recently, Sathe and Rahalkar (1975) have estimated 28 species of *Agaricus* from South-West India, belonging to seven families. Of these *Agaricus compestris* L. ex. Fr. and *Pleurotus corneopias* Roland are commonly edible. Purkayastha and Chandra (1976) have described 105 species of edible mushrooms belonging to 62 genera. While there are many poisonous or non-edible mushrooms. However, it is not easy to identify with certainty which mushrooms or agarics are edible and which are not. The general belief that white or uncoloured mushrooms or Agarics are edible and that all coloured mushrooms or agarics are poisonous is also not correct. The identification of poisonous mushrooms is the job for the experts, because out of two species of the same genus one may be edible and other poisonous. For example, famous *Amanita muscaria* which is *Somalata* according to Wason (1971) is edible and non-poisonous while *Amanita phalloides* (Death Cap) is not edible.

The colour shape, lamellae, taste, odor and spore are the characters generally used in identifying or distinguishing mushrooms. But as a general rule, it is advisable to know precisely which mushrooms or agarics are edible.

Eating mushrooms is quite common in temperate countries. They are quite tasty and nutritious in point of proteins and fats. They are also consumed in a similar way throughout Kashmir and States adjoining Himalayas, such as U. P., Assam, Sikkim, Bhutan, etc., but not in Peninsular India. Mushrooms are used in vegetables, soups, pulav, ice-cream, etc. They are considered delicacy on the table. However,

they are slowly getting popular in large cities like Bombay, Nagpur, Pune, Aurangabad etc. In some places attempts have been made to raise the crop of mushrooms by special culture methods which are taught at Shrinagar in the Regional Research Laboratory which is a branch of Council of Scientific and Industrial Research (C.S.I.R.).

Studies on them are rather scanty and are being made in Council of Scientific and Industrial Research, by Shri Gupta at the National Botanical Garden, Lucknow, by Dr. B. V. Patil and his associates at Amravati, Dr. A. V. Sathe at M. A. C. S. and Dr. S. D. Patil at Poona University. The list of edible mushrooms and agarics is given from previous works, including that of Butler and Bisby (1918). The list of poisonous mushrooms is also similarly given.

17·1 List of Edible Fungi

(1) *Agaricus comprestris* Fr.
Locality : Surat and adjoining Dang region, and also *Agaricus vaginata*, *A* crosea which are edible.

(2) *Clavaria elata* (Masses.) Morgaon.
Stipe edible when young. Grows in coconut groves.

(3) *Clavaria pachyderma* (Peck.) Morgaon.

(4) *Coprinus comatus* (Mull. ex. Fr.) R. F. Gray.
Locality : Bombay, Nagpur, Baroda and other places.

(5) *Coprinus micaceous* (Bull.) Fr.

(6) *Hirneola auricula judae* (Bull. per. St. Amans) Berk.
Locality : Khandala, Bombay.

(7) *Hygrocybe pratensis* (Per. ex. Fr.) Donk.
Locality : Nagpur.

(8) *Lentinellus cochleatus* (Per. ex. fr.) Karst.
Locality : Nagpur.

(9) *Leucoagaricus naucinus* (Fr.) Sing
Locality : Nagpur.

(10) *Leucoagaricus cepaestipes* (Sow. ex. Fr.) Patouill.
Locality : Bombay, Pune.

(11) *Marasmius oreades* (Bott. ex. Fr.) Fr.

(12) *Marasmius siccus* (Schw.) Fr.

(13) *Morchella eoniea.*
Morchella esculenta (Pers. ex. st Amans).
It comes from U. P., Kashmir.

(14) *Pleurotus cornucopiae* (Paulet ex. pers.) Roland.
Locality : Madhya Pradesh, Goa.

(15) *Pleurotus ostreatus* Kummer (Jacquin. ex Fr.).
Locality : Baroda.

(16) *Volvariella displasia* (Berk and Br.) Singh.
Locality : Baroda.

(17) *Volvariella volvacea* (Bul. ex. Fr.) Smith.
Commonly, cultivated in cultures by mushroom growers.

18. Poisonous Mushrooms and Agarics

1. *Amanita phalloides*, known as Death Cap.—

Death of animals due to unknown causes is often duc to eating this fungus. Colour creamy white but never pink or purple, brown. The gills are first white then cream coloured or even greenish in colour. Common in grass-lands adjoining forests. Spores white.

2. *Amanita mappa* (Bulbous Amanita).—

Gill cap white with yellowish edge. Spores white, yellow cap on the gill cap distinguish it.

3. *Amanita muscaria* (Fly Agaric).—

It has bitter taste and brilliant dark scarlet coloured cap which is very large, sometimes 8 to 9 inches high and 6 to 8 inches across : Spores white.

4. *Lapiota cristata* (Crested Agaric).—

This is a small agaric with cap 2 inches in diameter. It strongly smells like radish. Colour white or creamy.

5. *Entoloma lividum* (Livid Agaric).—

Grows under large trees, dull or dirty yellow in colour. Spores pinkish.

6. *Inocybe patouillardii* (Red staining Inocybe) cap 2 1/2 inches across, red or brown, mild smelling, wax coloured. Edge always white, spores yellowish brown.

7. *Psalliota xanthoderma* (Yellow staining Mushroom).—

Cap ball shaped, rather with a flattened top, pure, white silky with strong unpleasant odour. Gills dull pinkish.

8. *Stropharis aeruginosa* (Green agaric or Verdigris agaric).—

Grows on damp soil in forest and in grassy places. Gill cap blackish green or purple. Gills blackish purple with light radish smell.

19. Polypores and Decay of Timber

Bracket Fungi or Polypores belong to the Class Basidiomycetes Order Hymenomycetales. They have sporophores or fruiting bodies which grow on the tree trunks and timber, very rarely on soil. The mycelium is produced from basidiospores, in tube-like basidia of various shapes. They may be sessile or may have a short stalk. The upper surface is smooth and variously coloured. But on the lower surface there is a hymenial layer from which the basidia are formed. The hymenium is the fertile region of the fungus from the lower surface of which sterigmata and sterile cystidia and setae are formed. They are highly susceptible to temperature and humidity and get dried up in hot weather. It has been found that the activity of the spore formation and wood destroying is stopped at a temperature 60 to 90°. They are also very susceptible to humidity, and under favourable conditions grow enormously all around the trunk of trees, or on the wood kept for drying. They some times work great havoc to forest logs and tree trunks by their hyphae ramifying inside them and spoil the quality of timber. They live on the food materials in the cells or the lignified walls and seriously affect wood reducing its strength. They also attack Bamboos and thereby hasten the

decay. Such a Bamboo gives stained pulp, having lesser strength. Sometimes in depots the wood is so heavily attacked that the wood becomes almost pulp. Generally most of them attack sapwood but not the heart wood. The main decay causing fungi of wood are species of *Fomes, Polypores, Ganoderma lucidum lenzites sepiaria* Merulius *lacrymans* found on timber of different trees. Humidity and rainfall greatly influence the decay of wood.

TABLE No. II-20

19·1 Wood Rotting Fungi

1. *Daedalea suberosa* Mass (Pune)
2. *Daedalea spp*. Pune.
3. *Fomes senex* Nees and Mont. Bombay.
4. *Ganoderma applanatam* ((Pers) Pat. Khandala
5. *Gan. colosum* (Fr.) Bres. Konkan, Pune.
6. *G. lucidum* (Leyss.) Karst. Kolhapur.
7. *Hexagonia tenuis* Hooker. Khandala.
8. *H. subtenuis* Lloyd. Bombay.
9. *H. discopoda* Pat and Har. Kolhapur.
10. *Irpex canescens* Fr. Khandala.
11. *Irpex vellecus* Berk and Br. Khandala.
12. *Irpex* spp. Kolhapur.
13. *Lenzites ochrolenca* Lev. Khandala.
14. *Polyporus campbelli* Berk. Pune.
15. *P. gilrus* Schw. Khandala.
16. *P. grammocephalus* Berk. Pune, Panhala.
17. *P. hobsoni* (Berk) Cooke, Bombay.
18. *P. persooni* Fr. Andheri. Bombay.
19. *P. sanguineus* Koltzsch. Andheri, Bombay.
20. *P. umbilicatus* Berk. Bombay.
21. *P. ungulatus* Berk var *hobsoni* Sau. Pune, Bombay.
22. *Polystictus floridanus* Berk. Khandala.
23. *Polystictus occidentalis* Koltzsch. Pune.
24. *Polysticus persooni* Fr. Andheri, Bombay.
25. *Polystictus russogramme* Berk. Khandala.
26. *P. sarawalensis* Berk. Khandala.
27. *P. zanthopus* Fr. Khandala.
28. *P. zylanicus* Berk. Khandala.
29. *P. zonatus* Fr. Bombay.
30. *Polystictus* sp. Amba Ghat, Dajipur, Radhanagari.
31. *Poria carterii* Berk. Bombay.
32. *P. barbaeformis* Berk et Curt. Pune.
33. *P. poriginosa* Berk. Bombay.
34. *Trametes carterii* Berk. Bombay.
35. *Trametes* sp. Khandala, Panhala.

20. Soil Fungi

Soil is a complex organisation derived from the underlying rock, mixed with remains of animals, debris and plants. It provides food to them during life-time and also a graveyard after death. In this ecosystem or the process of soil building, bacteria and fungi, rodents and excreta of animals, play important part and they enrich it by various life activities. The fungi and bacteria are thus soil building organisms helpful to man. They play a significant role in accumulating salts of different minerals and humus in soil. They hold together the various plant products, their exudates from roots and underground parts. It is well-known that rhizosphere of different species contains different fungi and bacteria, who generally are attracted to them by the auxins, carbohydrates, mucilage, hormones and other products of secretion from the roots. They also help in building soil and make it fertile by growth of mycelia. They are important in the formation of compost, but what exactly do they secrete, or what processes they help is not yet known.

The fungi that mainly take part in it are known. They mostly belong to Phycomycetes, Ascomycetes and Fungi Imperfecti. Of these Phycomycetes are the most important being soil builders. Their mode of reproduction being mostly vegetative, in *Fungi Imperfecti* such as *Fusarium*, *Rhizoctonia* they are not only soil fungi but they also enter into partnership with grasses and other plants and lead a symbiotic life, Mycorrhiza often reproducing only by a sexual spores or conidia. They also play very important role in forest soils, inasmuch as they are the main litter builders and decomposers of cellulctic material. Without the presence of leaf litter fungi, deciduous and tropical forests would become infertile. Their role in moist soil and in soil at the bottom of shallow tanks, ponds and water reservoirs leads to a variety of life at the bottom of ponds, especially the Monoblepharidaceae. It is the main group which its activity make food for the aquatic animals and water plants. The soil fungi thus are extremely helpful from point of view of agriculture, horticulture and forestry.

Recently fungi have acquired special significance inasmuch as they have provided fungal resources for getting antibiotic substances *Penicillin*, *Aureofungin*, *Chloromycetin* etc. Their total potentiality for human welfare is yet to be fully understood. The lists of soil fungi common in this part of country and sources of antibiotics obtained from some of them are given in Tables below.

Principal families of soil fungi belong to *Phycomycetes* mainly : Mucoraceae, Saprolegniceae, Peronosporataceae, Pilobolataceae Pythiaceae.

Among Ascomycetes Pezizaceae and among *Fungi Imperfecti* Sphaeropsidaceae, Moniliaceae and Tuberculariaceae are important. The principal fungi concerned however are the species of *Mucor*, *Rhizopus*, *Absidia*, *Circinella*, *Allomyces* *Pilobolus*, *Saprolegnia*, *Phytophthora*, *Cystopus*, *Pythium*, *Aspergillus*, *Penicillium*.

But more troublesome members of soil fungi are those which belong to *Fungi Imperfecti* such as *Phomopsis*, *Fusarium Rhizoctonia*, *Monilia*, *Botrytis*, *Xylaria*, *Rosellina* etc. A large number of Hyphomycetes are leaf litter forming fungi. They are largely responsible for the decay of leaf molds, and humus formation in forests. In this *Cladosporium*, *Cephalosporium*, *Chlamydorabra*, *Cycadomella*, *Emmsia*, *Sphaeronema* (Indica) *Torula multispora*, *Monosporium bharatensis*. *Microsporium*

gypsum are very conspicuous as soil fungi. It should however be noted that all of them occur at the same place or at the same time in agricultural fields or forest area. Generally species of *Phoma. Cephalosporium* are pretty common. In forest soils *Cladospora* are more abundant. The fungi also grow on the dung and excreta of wild and domesticated animals such as elephants, horses. cattle etc. Various species of fungi occur on them. *Absidia regneria* occurs on the dung of a camel as well as species *Circinella spinosa* which also occurs on the dung of buffalow. *Helicostylum peforme* grows on the dung of elephant. *Sarcoscypha* grows on highly rich humus soil. Many species of *Agaricus* such as *Agaricus woodrowii, Bolbitius grandiusculus, Battararea levispora, Cyathus limbatus* and *Cyathus microsporus Dictyophora indusiata* Pers. (*D. falloides Desvaux*) species of *Lepiota* grow on ground, dung as well as in open grassy pastures.

21. FUNGI OF PALMS. GRASSES AND SEED BORNE

Palms constitute a conspicuous group of plants in the coastal regions and are also cultivated in gardens, and orchards. They are economically important. Many of them die due to attack of *Koleroga* by *Phytophithora arecae* and a few other fungi. They being very tall, infection on them is hardly noticed till the cabbage of them is fully infected and the trees die.

Another disease of coconut palms is '*Band* disease' which is a deficiency disease. The tree dies from top and becomes a prey to fungi. *Borassus flabellifer* dies due to nesting habits of birds. Infection on various *Phoenix* species due to *Graphiola phoenicis* is pretty common. *Cocossucifera* is also sometimes attacked by *Ganoderma, Oidium, Pestilochia palmarum. Graphiola borei* attacks *Borassus flabellifer* and also *Exosporium palmivorum.*' *Phytopthora arecae* causes damage to betel-nut trees.

Some imperfect fungi are seed borne. The fungus on the seeds of *Paspalum scorbiculatum* (Harikh) is known to cause symptoms similar to those of ergotine or opium. All these fungi need careful watching as they are consumed by cattle and man unknowingly. About 30 fungi are known on grasses.

The fungi growing on grass and fodder especially the smuts and Rusts cause damage to green grass and grains on storage. They harbour poisonous fungi too. Therefore, it is important to take a note of the fungi on fodder grasses and foodgrains consumed. Any fungus which grows on wild plants can as well affect cultivated or wild grass and their grains during some stage of their life cycle. Sometimes cattle die after eating them, especially the smuts. In Maharashtra, there are about 250 species of grasses. They are known to harbour 8 species of smuts, 1 of rust and 19 of other fungi.

22. MYCORRHIZA

Some fungi affect roots of grasses and live symbiotically with them. Species of *Rhizoctonia* and *Fusarium* live symbiotically on the roots of *Cynodon dactylion* and other grasses and also on the roots of some ornamental and cultivated plants. *Fusarium* causes well known '*Wilt Disease*' of cotton. The roots of conifers always live symbiotically with fungi. They harbour fungi on roots externally as well as internally. Such a fungal association with roots is known as mycorrhiza and is not uncommon.

23. Useful Fungi

Industrial Uses of Fungi.—So far we have discussed the harmful role of fungi in causing diseases to plants, animals, man, his crops and useful plants, but it should not be considered that fungi are not useful. It is well-known that some of the Mushrooms form delicious food for man. Some are added to beverages for aroma and flavour. They yield various organic acids like glycolic, glucosonic, citric succinic acid etc.

But above all, the yeasts are known to produce alcohol, vitamins and enzymes since man started utilizing plants. The main groups useful for this purpose are Zygomycetes to which *Mucor*, *Rhizopus*, *Absidia* (all Phycomycetes) belong. Among the *Ascomycetes Eurotium*, *Monascus*, *Neurospora* yeast are important. They bring about a variety of fermentation so much so that a separate branch of technology called Fermentation technology has been developed. A new Fungi Imperfecti like Actinomycetes, various types of *Hyphomycetes*, *Phoma*, *Aspergillus*, *Penicillium*, *Cladosporium*, *Helminthosporium*, *Alternaria* are some of the more important fungi.

A new interest in industrial mycology has arisen with the discovery of Antibiotic Penicillin by Alexander Flemming in 1929 from the common green mold *Penicillium*.

Since the discovery of *Streptomycin*, there is a continuous search the world over for fungi and bacteria in soils. A few pharmaceutical works also keep on searching and preparing drugs from Fungi useful to man and the total number of antibiotics so far known is more than 2000. Many have been investigated only in the laboratory, only a few however reached the pilot or factory stage. The main difficulty in dealing with them is that many important fungi and their spores are usually propagated vegetatively. Like all lower fungi and bacteria they mutate rapidly and such changes are often prompted spontaneously or by the substrate, warm temperature, and other conditions in which the broth or culture is made. Therefore at every step extreme care is taken in preserving an antibiotic fungal strain. The same is true of various yeast strains as they produce both haploid and diploid spores. To preserve the same quality of yeast for bread making or for the production of alcohols immense care is taken and secrecy is maintained by the organizations concerned. The following Table gives the main industrial fungi and other micro-organisms and their useful products to man.

24. Yeast and Fermentation

Use of yeast to man is known since very very long time. Industrially they yield alcohol, riboflavin etc. Yeast is used in fluffing wheat paste into bread known as Baker's yeast. It is different than Brewer's yeast giving alcohol by fermentation of sugary solutions. (see tables Nos. II-21 and 22)

25. Fungi And Human Diseases

Fungal attacks cause diseases to man also. The chief disease forming fungi belong to various groups especially to molds *Phycomycetes*, *Actinomycetes* and *Fungi imperfecti*. This branch of mycology is much neglected Types of diseases like *Candidas* causing superficial

irritation are not easily removed. Phycomycetous Fungi and Fungi Imperfecti cause systemic disease which are more troublesome to irradicate, especially those causing pulmonary diseases like asthama, spores of various fungi responsible for deep infection of the pulmonary tract in man. On the other hand a disease like *Madura mycosie* is caused by *Mycotoma* or *Allescheria boydii* or some times by species of Aspergillus. In Maharashtra *Rhinosporidium* of nose and foot is quite common in workers collecting sand from river bed, or from estuarian and river beds. Species of *Rhizopus* and *Mucor* causing ear diseases are also common. A list of some common human diseases caused by fungi, for their symptom, etiology, distribution works like *Medical Mycology* by Moss and Mc Quiwn (1971), 3rd edition, be consulted.

Similarly there are many aquatic fungi and marine fungi which are quite important as they grow in lake water, estuaries and river banks causing diseases to aquatic animals. These branches are very poorly looked into by mycologists who mainly concern themselves with plant diseases, those too of crops.

26. Antibiotics and Their Sources And Antibiotics Discovered by Hindustan Antibiotics Ltd., Pimpri

Some diseases are also transferred from animals to man like T. B. and they are known as zoonoses. List of some diseases caused to man by fungi called from various sources, and the list of antibiotics used against some of them, are given in tables Nos. II-23 and 24.

In India some antibiotics have been discovered by the research staff of the Hindustan Antibiotics Ltd., Pimpri and that list is also given in table No.II-25.

TABLE No. II-21

Micro-organisms Producing Considerable Riboflavin and the effect of Iron on the Biosynthesis

	Organism	Riboflavin in culture fluid ug per ml	Optimum iron concentration by per ml
	(1)	(2)	(3)
1.	*Mycobacterium smegmates*	57.5	Not critical.
2.	*Clostridium acetobutylianum*	97.0	1 to 3.
3.	*Mycocondida riboflavina*	200.0	Not critical.
4.	*Candida flareri*	567.0	0.04 to 0.06.
5.	*Ashbya gorrypii*	1,760.0	Not critical.
6.	*Eremothecium ashbyeii*	2,480.0	Not critical.

TABLE No. II-22

Alcoholtolerance of Certain Distiller Yeasts

No.	Yeast culture name	Alcohol tolerance per cent by Wt. alcohol
(1)	(2)	(3)
2	*Saccharomyces cerevisiae* Housen	5.79
19	*Lygosacharomyces soja*	4.82
1	*Saccharomyces cerevisiae* Honsen	7.72
26	*Saccharamyces mellacei* Jorgenson	7.72
24	*Saccharomyces ellipsoidens* Housen	9.65
25	*Saccharomyces* Pombe	8.68
29C	*Saccharomyces cerevisiae* Hansen-Rasse XII ..	8.68
4C	*Saccharomyces cerevisiae* Hansen-Rasse XII ..	8.68
3C	*Saccharomyces cerevisiae* Hansen-Rasse XII ..	10.61
28C	*Saccharomyces cerevisiae* Rasse M	10.61
31C	*Saccharomyces cerevisiae* Rasse M	11.58

TABLE

TABLE No. II-23

Fungal Diseases of Man

Serial No.	Name of disease	Causal organisms	Parts affected	Distribution	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
1	Actinomycosis	*Actimomyces israeti*	Cervicofacial (57 percent) Thoracic (15 per cent) abdominal (22 per cent) Cutaneous organalised (6 percent)	World-wide.	
2	Nocordiosis	*Nocordia asteroides*	Vicero	World-wide	In both sexes.
3	Mycotoma	*Nocardia* sp.	Any part but frequency the foot and hands.	World-wide	Men are more affected.
4	Trichomycous axillaries laptothrix.	*Nocardia tenuis*	Infection of hair of the oxillary and pubieregional region.	Yellow variety World-wide.	Condition occurs in man and woman past puberty
5	Frythrasma	*Nocardia minutissima*	Webs and between toes	Red and black tropical	It occurs at any age, affects men frequently.
6	Cruptococcosis (Torulosis).	*Erytococcus neaformans*	Tissue central nervous system	In all parts of world	It affects men and women equally.
7	Cendidioris Monilians	*Candida albicans*	Any part of body	S. America	Occurs at all ages.

8	Histoplasmeris	*Histoptasma capsulatum*	Reticulo-endothecial	Asia, Australia, Phillipines.	Both sexes.
9	Aspergillosis	*Aspergillus* sp.	Even to birds, animals and insects.	World-wide	Men are infected.
10	Phycomycosis	*Mucorales Rhizopus oryge Rhizopus arrinisus Absidia corymbifera.*	Skin	World-wide	Both sexes at all ages.
11	Penicillosis	*Penicillium* sp.	Pulmonary, Urinary tracts	Tropics and sub-tropics.	No age or sea bar.
12	Tinea nigra Palmarus	*Clodosporium*	Skin also other parts	Tropics and sub-tropics.	Both sexes at all ages.
13	Dermatomycoses	*Epidermophyton flaccosum* (Harg) Langeren and Mito Chentch. 1930.	Skin and nails	World-wide	Men and women are equally affected.
14	Tinea capitis	*Microsporum*	Hair, skin	World-wide	Men and women are equally affected.
15	Tinea corporis	Gruby 1845	..	..	..
16	*Tinea capitis*	..	..	..	..
17	*Tinea corporis*	*Trichophyton*	Hair, skin, nails	World-wide	Men and women are equally affected.
18	*Tinea barbae*	*Mentagrophyres*			
19	*Tinea crulis.*	Robin			
20	*Tinea pedis* and	Blandhard 1896			
21	*Tinea unquium.*				

TABLE No. II-24

Antibiotics and Their Sources

Antibiotic (1)	Source (2)
Actinomycin A. B. C.	*Actinomyces* antibioticus etc.
Actinorubin	*Actinomyces* Strain A 105.
Antimvein A	*Streptomyces* (Unidentified).
Aspergillic acid	*Aspergillus flavus.*
Aureothricin (cf. thiolutin)	*Aspergillus fareinicus.*
Ayfivin (same as Bactitracin A, B and C).	*Bacillus licheniformis* Strain A. 5
Borrelidin	*Streptomyces rochei.*
Candidulin	*Aspergillus candidus.*
Chetomin	*Chaetomium cochliodes* etc.
Citrinin	*Penicillium citrinen* etc. *Aspergillus niveus.*
Enniatin (A, B, C.) (Lateritiin, avenacin, Fructigenin sambucinin).	*Fusarium orthoceras Var* ennicitinum etc.
Fumigacin (Helvolic acid)	*Aspergillus fumigatus.*
Fumigatin	*Aspergillus fumigatus.*
Geodin	*Aspergillus terreus.*
Gladiolic acid	*Penicillium gladioli.*
Gliotoxin	*Trichoderma lignorum* (viride) *Aspergilli* and *penicillia.*
Glutinosin	*Metarrhigium glutinosin.*
Glyco-lipide ariseolutein	*Pseudomonas aeruginosa.*
L-Hydroxy-phenagine (Hemipyocyanine).	*S. griseoluteus Pseudomonas pyocyanea.*
Illudins	Caeruginosa.
M. and S.	*Clitocybe illudens.*
Iodinin	*Chromobacterium iodinium.*
Javanicin	*Fusarium javanicum.*
Kojic acid	*Aspergillus flavus*, etc.
Lavendulin	*Organism resembling Streptomyces lavendulae.*

Antibiotic (1)	Source (2)
Licheniformin	*Bacillus lichenif.*
Marasmic acid	*Marasmius conignus.*
Lenolic acid	*Penicillum brevicompactum* etc. *Bacillus subtilis* 370.
Nisin	*Streptomyces netropsis.*
Patulin (clavacin clavatin Claviformin expansion). ..	*Penicillium patulin*, etc. *Aspergillus clavatus* etc.
Penicilic acid	*Penicillium puberulum*, etc.
Pleurotin	*Aspergillus ochraceus*
Poactinomycin A, B, C.	*Pleurotus griseus.* *Proactinomyces* (Nocardia) *gardneri.*
Prodigiosin	*Serratiaaeemarcescens.*
Puberulonic acid	*Penicillium puberulum*, etc.
Puberulonic acid	*Penicillium aurantiovirens*, etc.
Pyo compound	*Pseudomonas acruginosa.*
Pyocyanine	Pseudomonas acruginosa, etc.
Pylolipic acid	*Pseudomonas pyocyanea.*
Streptolin	Streptomyces (Unidentified).
Streptothricin	*Streptomyces lavendulae.*
Subtilin	*Bacillus subtilis.*
Sulfactin	*Actinomyces* sp.
Thiolutin (cf. oureothricin) ..	*Streptomyces albus.*
Toluquinone	*Coprinus simulus.*
5-methoxy-p-toluquinone)	*Lentinus degner.*
Ustin, I, II, III	*Aspergillus ustus.*
Viridin	*Trichoderma viride.*
Xanthomycin	*Streptomyces* (Unidentified).

TABLE No. II-25

26. LIST OF ANTIBIOTICS REPORTED FROM THE RESEARCH DEPARTMENT OF HINDUSTAN ANTIBIOTICS CO. PIMPRI, WITH ORGANISMS PRODUCING THEM

1.	Antismobin	*Emoriceliopsis peonomis* Thirum.
2.	Antibiotic MyV-4	*Streptomyces* sp HA-MYC-4.
3.	Antibiotic s-39	*Streptomyces* sp.
4.	Antiprotozoin	*Streptomyces hygroscopicus* vars *indica.*
5.	Antibiotic related Abiromycin.	*Chainia minuticclerotica.*

6.	Aureofungin	*Streptoverticillium.*
7.	Chainin	*Chainia strain* 3047.
8.	Dermostetin	*Streptomyces viridigriseus.*
9.	Fucothricin	*Streptomyces* sp. MYC-19.
10.	Hamycin	*Streptomyces pimprina.*
11.	Herbarin A and B	*Torulaharbarum.*
12.	Herquinene	*Penicillium herquei*
13.	Hexin	*Streptomyces* sp. (AFS2).
14.	Necrocitin	*Myrothecium roridium.*
15.	Neoheptaene	*Streptomyces* sp. HA/711.
16.	Neopendaene	*Streptomyces* sp. No. 2236.
17.	Streptorubrin	*Streptomyces rubrireticuli* var *pimprina.*
18.	Streptombrin B	*Streptomyces reseoverticillatus* var *alberpora.*
19.	Tetraenine A and B ..	*Streptomyces freqmentans* Thirum.
20.	Streptorubrin A	*Streptomyces nibrireticuli* var *pimprina.*

All these are used against several diseases.

27. FOOD SPOILAGE ,MYCOTOXINS AND HUMAN HEALTH

Spoiling of food by fungi is known since long. Many molds contaminate food, especially on bread. They develop a toxin akin to lysergic acid-LSD. Grains of cereals affected by molds produce toxins called Mycotoxins. Leaves of coconut become yellow due to mycoplasma. Yellowing of rice grains and other cereals like maize also develop mycotoxins. Broken grains *i.e.* seeds of groundnut, Pristachio nut (Pista) are affected on storage, especially under damp conditions by molds like *Aspergillus flavus* or *A. paraeitieus* which produce mycotoxins. Some of these are quite serious and cause damage to human health, to cattle and poultry. They affect liver and kidneys by their toxins. Cattle can even die because of them. Species of *Aspergillus* like. *A. flavus, A. clavatus* are supposed to be carcinogenic. Some *Fusarium* species are also highly toxic. Aleukia which affects leucocytes is due to consumption of wheat and millet grains infected by *Fiwarium* S. P.

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SECTION C -LICHENS

1. General introduction to lichens in Maharashtra

The next class of the Thallophyta is 'Lichens'. It is an association of two different components, one of which is an alga and the other a fungus; but together they make and look a single plant. The fungus is the dominant partner. It completely engulfs the algal component. They grow together and help each other. What the fungus alone cannot do, the fungus and alga together are able to do. The alga manufactures food by photosynthesis and supplies it to the fungus and the fungus utilizes algal products by engulfing the alga by its mycelium. Fungus provides salts. The two partners of each lichen are characteristic and do not change. They can rarely be separated. There are above 15000 known species of lichens, but according to some 20,000 in the whole world belonging to 400 genera. The number of algae in lichens is about 25, belonging to three families Cyanophyceae Chlorophyceae and Xanthophyceae; the fungal members belong to only 2 taxa. They alone constitute the fungal components. They are Ascomycetes and Basidiomycetes. In the case of algae Chlorophyceae are more common than Cyanophyceae. Since the fungal partner is dominant in lichens, the name is generally given after the fungal partners e.g. Ascolichens. Heterotrophic purple bacteria are also seen associated with lichens, but

the separation and reconstitution of a lichen by synthesis is extremely difficult and has been rarely achieved as in the case of a Basidiolichen. In 1886 Bonnier succeeded in synthesizing various lichens from the two components and showed that it was possible to obtain fruiting bodies from the association of fungal hyphae and free algal cells isolated from it. Even at present it has not been possible to isolate the fungus and grow it to maturity in pure ascus culture.

It is obvious that this is a case of nutritive symbiosis, but sometimes when the algal partner is overpowered, it leads to helotism and the lichen dies. They grow on rock, soil, bark of trees, leaves and even on human skin.

They extend from extremely cold regions such as Arctic Tundra where randeer moss *Cladonia rangifera* grows to hot rocks. It forms dark carpets in Tundra, sometimes 15 to 30 cm thick. Lichens are the first colonisers of rocky habitats followed by Blue-green algae, mosses, liver worts etc. Because of the mucilage secreted by them they grow even in the chinks of rocks and bring about the decay of substratum. They are thus the real pioneers in a seral succession. They are classified according to fungal partner into (1) Ascolichens in which the Ascomycetes is one partner, and (2) Basidiolichens with a Basidiomycete as one partner. The algal as well as fungal partner are permanently fixed in a lichen.

Some of them form crust on the rock and are known as Crustose lichens e.g. genus *Parmelia.* Sometimes a lichen grows in bits as if parts of a broken layer, and sometimes all fragments grow together erect. If the humidity is high they dangle in the air as if branches of a tree, e. g. Usnea. Still others form rounded Cephalodia or heads and still others form thallus cups as in *Physcia.* The distribution of fungal hyphae and the algal particles is characteristic of each lichen. They form pseudohypodermal layers and sometimes a central layer in the thallus. Sometimes algal particales are scattered throughout thallus. They reproduce vegetatively by fragments of thallus. Cephalodia are also formed as special joint reproductive bodies which in dry air form powder on the thallus and it flies off. They are called soredia and the group which germinates under such conditions is known as Sorelia. They also form pycnidium and spores in ascus cup, with fungal hyphae intercepting algal chains alternately. They can reproduce sexually in the case of Ascolichens by forming ascogenous hyphae, but attempt to separate them and bring about fertilization has not succeeded. They form two groups: (1) Pyrenocarpic where ascogonium lies within a perithecium and the other (2) Gymnocarpic. Here it lies in apothecium. Sixteen lichen families belong to group (1) and thirty-five families to the other group (2). Compared to them Basidolichens are very few.

2. Basidiolichens

Only 3 genera constitute the group and in actual growth they form concentric layers which look as if they are a polypore or an *Agaricus.* Algal component is generally *Chroococus.* Distribution of the two is irregular, alga forming lower or inferior layer, the fungus running through it above as a superior layer. Some Basidiolichens reproduce by the formation of 4 basidiospores on each terminal sterigmata. *Chroococus* is sometimes replaced by filamentons Blue, green alga *Scytonema.*

Generally lichens are very varied and abundant in tropics. In India Awasthi (1965) has enlisted 1310 species spread over 158 genera. The variety of terrain, variation in climate and humidity have greatly favoured the formation of various lichens in India. Those that occur in Western Himalayas are about 30 in the neighbourhood of Mussouri (Quraishi, 1928). They also occur in Pulney hills (Choisy, 1931). He added 2 new genera and 3 species. Those in Himalayas are described by Chopra (1934), and also those in Vajiristan collected by Blatter. There are 80 species, 38 genera of Ascolichens (Biswas and Awasthi 1948). Later workers have however added many more. In 1961, Awasthi studied the lichens both in field and herbaria and has enumerated many more in his *Catalogue of Indian Lichens* (1965). So did Ajit-Singh (1964). He enumerates 946 species and 143 genera.

The study of lichens is important from various points of view. They contain lichenic acids, and have medicinal properties. A number of them have been chemically investigated by the late Dr. Sheshadri and his school. Their history is given by Ajit Singh (1964), Awasthi (1965). Hale. Patwardhan et. al (1971-1973) are writing a series of articles on lichens of Western Ghats and Peninsular India. According to Awasthi (1965) 1310 species of lichens are distributed over 158 genera in India. This is a very small number as compared to the size of a country like India and the variety of situations in which they can grow here. The main families represented in Maharashtra are Arthoniaccae, Thelotremaceae, Lecideaceae, Graphidaceac, Lecanoraeae, Parmeliaceae, Pertusariaceae Physciaceae, Teloschistaceae, Usneaceae. Thirteen families, 16 genera and 29 species of lichens were estimated in Western India upto 1972. The largest family is the Physciaceae. The further addition are many : Hale, Patwardhan and their associates.

Since the Maharashtra State is vast and has high hill stations with high humidity variety of climatic zones, these numbers cannot be taken as final. The largest number of species occur at Khandala, Mahabaleshwar, Matheran, Castle Rock and in parts of Melghat and such other places. They are being studied by P. G. Patwardhan and his associates.

From the view point of biochemistry, lichens these days are getting important. They can be classified chemotaxonomically.

Many species of lichens are used for the production of dye-stuffs like Orchil which contain the colouring matter orcein. It is used in dyeing brown and buff colours on wool and silk. *Lecanora* and *Rocella* species are mainly used for it. The lichens *Rocella montagnei*, contains (i) Erythrin and crythrotol, besides small quantities of free orcinol, (ii) Lecanoric acid, eruthritol and rocellic acid and small quantities of free orcinol, (iii) Montagnitol, orcinol, erythritol and rocellic acid.

It has now been found that the newly discovered compound,montagnitol is a derivative of orcinol and promises to be a source of orcinol, being rich in it. *Parmellia abessirica* from Bellary and Cuddapah districts in South India contains lecanoric acid 3.3% and atranorin 1.1%.

By a modification of the process adopted for the preparation of orchil, the colouring matter contained in the commercial samples of litmus, is obtained. An estimation of the orcinol content in two lichens by the Remann method gave the following values.

Rocella montagnei	... ...	3.4%
Parmelia abessinica	... ...	3.1%

The main genera investigated by Dr. Sheshadri's school are *Parmelia*, *Ramalina*, *Usnea*, *Rocella*, *Thelotrema*. The lichen *Dermatocarpon moulinsii* (Mont.) Zahlbr., gave amino acids.

3. Distribution of Lichens in India

In the *Catalogue of Lichens of India* by Awasthi (1965) nearly 1310 lichens have been enlisted. A perusal of his list shows only one or two Lichens of Western Ghats and a few more from Peninsular India. The rest are from Eastern, Central and North-west Himalayas, where they have optimum conditions for their growth. Indo-ganga plain is mostly devoid of lichens. Since the distribution of lichens at several places is yet to be known, it is difficult to comment upon the phytogeographical distribution of lichens in India as a whole. In the Eastern Himalayas there is a high correlation between the Lichen flora and the flora of higher plants. The Eastern Himalayan lichens show affinities with the Sino-Japanese lichens and with South East Asian elements e.g., *Alectoria asiatica* Du Rietz., *Parmelia* species, *Ramalina sinensis* Jatta, *Usnea asahineae* Mot. etc. The lichens from the Western Himalayas show close relationship with the European element e.g. Cetrgria *pinastri* (Scop.) Rohl, *Lobaria, discolor* (Bory) Hue. etc. Some lichens like *Parmelia cirrhata* F. P., *Picnospersa tincotrum* Tayl. *Physcia setosa* (Ach.) Nyl. are cosmopolitan having circumpolar distribution. Some are also endemic.

Lichens in the foot-hills of the Himalayas exhibit affinities with the lichens of Tropical Asia and South-East Asia. Some species of *Physcia aegialita* (Ach.) Nyl., *P. picta* (SW) Nyl., *Pyxine berteriana* (Fee.), Imshaug., *P. cocoes* (SW) Nyl., *P. sorediata* (Ach.) Mont. *Rocella montagnei* Bel., are typical examples. Most of these are foliose and fruiticose lichens. The Crustose lichens are restricted to extreme xeric conditions. Foliose lichens are not many. As the lichens occur in isolated ecological nitches in the sholas of Peninsular India or in the interior mountainous regions of Maharashtra, some species are expected to be endemic.

4. Biochemistry and Culture of Lichens

Patwardhan and Hale are studying lichens to characterize them chemotaxonomically. Biochemistry of lichens has been studied by Asahima and Shibata (1954), Hale (1961) Sheshadri and his associates. Ahmedjian (1967) has studied respiration, resistance to temperatures, CO_2 absorption in lichens and has developed culture methods to isolate components. Lichens contain lichenic acids, polyphenols, vitamin C and even antibiotics. They are known for aromatic substances, particularly the Foliaceous cnes. In India the use of *Parmelia* species as spice is known since long.

Hale (1961) has given account of basic nature and physiology of lichens. Other references on chemistry of lichens are Smith A. 1921. *Lichens* Camb. Univ. Publ. pp. 464. Shibata, S. *Lichen substances* in "*Methods of plant analysis*", 1963. 6 : 155-193. Publ. Springer Verlag, Berlin. Smith, D. C. 1963. Biology of Lichen *Bot. Rev.* 37 : 537-570. 1960. Studies in the physiology of Lichen.

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For work on the Chemistry of Indian lichens refer to Dr. Sheshadri and his associates in *Wealth of India,* Vol. 6 : pp-82-90.

5. COMPONENT GENERA OF ALGAE PARTICIPATING AS PRIMARY SYMBIONTS IN LICHEN ASSOCIATION (After Ahmedjian, 1952, 1958, 1967).

The principal members belong to families Chlorophyceae, Cyanophyceae and Xanthophyceae. The list of Chlorophyceae and their symbiotic lichen association is given separately against the name of a genus in the Table No. II-26.

The principal genera concerned are :—

Chlorella, Gloeocystis, Pseudochlorella, Hyalococcus, Cephaleuros, Cephaleura, Pleurococcus, Stichococcus, Trentepohlia, all belonging to Chlorophyceae.

Hyella, Calothrix, Nostoc, Scytonema, Stigonema belong to Cyanophyceae.

Heterococcus belongs to Xanthophyceae.

The common lichen genera with symbiotic members belonging to Chlorophyceae as the partners are *Calycium, Cyalecta, Dermatocarpon, Sarcogyne, Verrucaria, Lacidea, Physcia, Polyblastia, Peltigera, Solorina, Coniocybe, Lepraria, Opegraphia, Pyrenula.* They are very common symbionts in tropics and subtropics.

Cyanophytic algae are found in the following lichen genera :—

Orthopyrenula, Porosyphus, Placynthium, Colluma, Leptogeum, Pannaria, Peltigera, Lichenothrix, Thermutis, Lichenodium, Soilonema Entebe and *Verrulcena.*

Heterococcus belonging to Xanthophyceae is found in *Monocilia.* Many lichens are frequently found in Konkan at places like Sasavane; Bhimashankar, Kodgaon, Castlerock, Anamod, Kodaikanal and in Coorg. They are being studied by Dr. Patwardhan and their associates at the Maharashtra Association for the Cultivation of Science, Pune, and in the Department of Lichenology, Smithsonian Institute at Washington by Dr. Hale and his associates.

TABLE No. II-26

6. LIST OF ALGAE NAMES REPORTED AS LICHEN SYMBIONTS (After Ahmedjian 1952)

Anabaena	
Aphanocapsa	Reported in cephalodia of *Stereocaulon-liaumanianum* Duvign.
Calothrix	
Cephaleuros	
Chlamydomonas	Found in an unlichenized association with the ascomycetous fungus *Humaria.*
Chlorella	
Chlorellopsis	
Chlorosarcina	
Chroococcus	
Chroolepus	Syn. *Trentepohlia*
Cladophora	Reported as symbiont of *Racodium rupestre* and *Blodgettia confervoides* Harv.
Coccobotrys	

Coccomyxa	
Cystocoecus	Syn. *Trebouxia.*
Dactylococcus	Occurring in *Psoroma.*
Desmococcus	Occur in *Thelidium hospitum* and *Endocarpon pusillum.*
Dichothrix	
Diplosphaera	Syn. *Stichococcus.*
Gloeocapsa	
Gloeocystis	Reported in Cephalodia of *Lepolichen coccophorus* and in *Lecidea uliginosa.*
Gloeotheca	
Gongrosira	
Heterococcus	Syn. *Monocilia.*
Heterothallus	A sub-genus of *Trentepohlia.*
Hyalococcus	
Hyella	
Jaaqia	
Leptosira	
Lyngbya	Reported in Cephalodia of *Stereocaulon ramulosum* and mixed with *Scytonema.*
Mastigocoleus	In *Arthopyrenia sublitorelis.*
Microcystis	In *Arthopyrenia.*
Mycoidea	Syn. *Cephaleuros.*
Myrmecia	
Nostoc	
Palmella	
Phycopeltis	
Phyllactidium	Syn. *Phycopeltis.*
Physolinum	
Pleurococcus	
Polycoccus	
Polycystis	Syn. *Microcystis.*
Prasiola	
Protococcus	Syn. *Pleurococcus.*
Pseudopleurococcus	In *Arthopyrenia sublitoralis.*
Rivularia	
Scytonema	
Sirosiphon	Syn. *Stigonema.*
Stichococcus	
Stigonema	
Trebouxia	
Trentepohlia	
Trochiscia	
Urococcus	In Cephalodia of *Lepolichen coccophor*
Xanthocapsa	Syn. *Gloeocapsa.*

7. Lichens in Maharashtra and Western India

		Locality
1.	*Pyxine endoleuca* (Mull. Arg.) Vuin.	Around Pune.
2.	*Parmelia wallichiana* Tayl ..	Mahabaleshwar-Wilson and Lodwick Points, Bhimashankar.
3.	*Anaptychia podocarpa* (Bel) Mass	Mahabaleshwar, Bhimashankar.
4.	*Anaptychia diademata* (Tayl) ..	Mahabaleshwar, Sinhagad, Bhimashankar, Purandar, Khandala.
5.	*Usnea cineraria* Mot. Lich. Gen.	Mahabaleshwar, Bhimashankar.
6.	*Lecanora chlorona* (Ach.) Nyl.	Pune.
7.	*Lecanora allophana* (wahlb) Rohl.	Mahabaleshwar.
8.	*Lecidea parasema* Ach. ..	Mahabaleshwar.
9.	*Graphis verminosa* Mull. Arg.	Mahabaleshwar, Khandala, Matheran, Bhimashankar.
10.	*Pertusaria pertusa* (L.) Tuch. ..	Khandala, Lonavale, Mahabaleshwar.
11.	*Graphina obtecta* (Nyl.) Mull. Arg.	Matheran, Bhimashankar, Khandala.
12.	*Graphis scripta* (L.) Ach. ..	Konkan.
13.	*Glyphis cicatricosa* Ach. ..	Konkan, Goa.
14.	*Phaeographina caesiopruinosa* (Fee) Mull-Arg.	Castlerock, Anamod.
15.	*Lecidea granifera* (Ach.) Vain.	Castlerock, Anamod.
16.	*Bacidia fuscorubella* (Hoffm.) Bausch.	Castlerock, Anamod.
17.	*Bombyliospora domingensis* (Pers.) Zahllr.	Allapalli forests, Chandrapur.
18.	*Lopadium leucoxanthoides* (Vain.) Zahlbr.	Castlerock, Anamod (Karnatak State).
19.	*Buellia leptocline* (Flot.) Corb.	Fergusson College, Hill, Pune.
20.	*Buellia disciformis* (Fr.) Mudd.	Kolgaon-Sasawane.
21.	*Ochrolechia subpellescens* Vers.	Mercara.
22.	*Diploschistes scruposus* (Schreb.) Norm.	Purandar.
23.	*Graphina poitiaei* (Fee) Mull .. Arg.	Mercara Forest (Coorg, Karnatak State).
24.	*Graphina acharii* (Fee) Mull Arg.	Yellapur (Karnatak State).
25.	*Sarcographa labyrinthica* (Ach.) Mull.	Mercara Forest (Coorg).
26.	*Coloplaca ferruginea* (Hudsth)	Kolgaon, Sasawane (Konkan)
27.	*Pyrenula Pinguis* Fee ..	Castlerock, Anamod.
28.	*Pseudopyrenula pupula* (Ach.) Mull. Arg.	Mercara Forest (Coorg).

29. *Graphis duplicata* Ach. .. Bhimashankar

30. *Pertusaria leioplacella* Nyl. .. Kolgaon, Sasawane.

31. *Catillaria leptocheiloides* (Nyl.) Zahlbr. Castlerock, Anamod.

32. *Arthonia einnabarina* (DC) Wallr. Mercara Forest (Coorg).

N.B.—All tables and lists have been compiled from various sources.

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CHAPTER III

BRYOPHYTA OR HEPATICOPSIDA AND BRYOPSIDA
(Liverworts and Mosses)

CONTENTS

BRYOPHYTA OR HEPATICOPSIDA AND BRYOPSIDA

(Liverworts and Mosses)

Bryophyta as generally understood consist of Liverworts and Mosses. They are also known as Hepaticaceae and Musci, respectively. They form a large group having 960 genera and 24,000 species. Of these liverworts or Hepaticaceae constitute 280 genera and 9,500 species; the rest belong to Musci. Liverworts from many parts of India and the world are yet to be known, especially the Western and Eastern Ghats, Central and North Eastern Himalayan region of India, Java, Australia etc. Therefore, these numbers are bound to be changed.

Both liverworts and mosses are homosporous and have been classified variously by different authors. They are now recognised as Hepaticopsida and Bryopsida by modern authors such as Engler, Melchoir and Wedermann (1954). Their earlier classification as given by Cavers (1911), Stepheni (1912-1917), Campbell (1918), Kashyap (1929)—Goebel (1930), Kashyap and Chopra (1932), Verdoorn (1932), Smith (1955), Prauskaur (1957), Schuuster (1958) and Engler, Merichoir and Wedermann (1954), Parihar (1965) etc differs in point of classes; sub-classes, Orders and families. Naturally, the systematic position of individual family or members is different in their systems. We shall however consider their taxonomic grouping (irrespective of their status) as given below :

HEPATICOPSIDA

Order 1	..	SPHAEROCARPALES
Family	..	Sphaerocarpaceae
Order 2	..	RICCIALES
Family	..	Ricciaceae
Order 3	..	MARCHANTIALES
Family	..	Marchantiaceae
Order 4	..	JUNGERMANNIALES
Sub-order	..	Haplomitrineae—Not found in Maharashtra
Sub-order	..	Jungermannineae (Acrogynae).
		Genera : *Frullania, Lejeunea, Radula, Leptocolea,*
Sub-order	..	Metzgerineae (Anaerogynae)
		Genera : *Fossombronia, Aneura* or *Riccardia, Pallavicinia, Metzgeria.*
Order 5	..	ANTHOCEROTALES
Family	..	Anthocerotaceae
Order 6	..	CALOBRYALES
Order 7	..	TAKAKIALES

The last two Orders.—CALOBRYALES and TAKAKIALES have been left out of detailed consideration as they are very rare and are known only from Eastern Himalayas in India discovered by Ram Udar and Chandra (1961-1965). Similary the Australian genus *Monoclea*

not found in India, is somctimes treated as a distinct Order Monocleales. It also is not considered here. All the three liverworts are important from the evolutionary point of view. The commonly represented families in Maharashtra are Ricciaceae, Marchantiaceae, Jungermannieae leafy and fleshy, and the Anthocerotaceae. The number of genera and species under each are shown against their names in bracket. We have, not considered much the Sphaeroearpales as the only representative genus of it is *Reilla* found in Gujarat, but not in Maharashtra.

The classification of Musci-mosses or Bryopsida adopted here is that of Dickson (1932) and Bruhl (1931) as given in his *Census of Indian Mosses*. Both these groups have recently been studied and revised by Chopra (1974), Gangulee (1962), Steere (1958) and Dabhade (1974).

Liverworts and Mosses are very small non-vascular plants, but they constitute an important step in the evolution of land plants (Campbell, 1908; Bower, 1908, 1935). They all have ended blindly due to their inability to develop effective means of absorbing water, transportation of food from soil under sub-aerial conditions on the land and possibly due to lack of heterospory. They all belong to the gametophytic or haploid generation.

A complete survey of Liverworts and mosses in Maharashtra has not been made. Stray references to them are found in literature and in the papers by Mahabale and his associates, Gorji (1947), Deshpande (1947); Bhate (1945), Raje (1945), Dabhade (1974), and in the papers of Ram Udar (1956-1965), Kashyap (1929), Kashyap and Chopra (1932), Schiffner (1893), Blatter (1929), Dixon (1932), Pande *et-al* (1954), Bhardwaj (1950-1960), Ram Udar (1970) etc.

The main places from where these plants are generally collected are Mahabaleshwar, Panchgani, Lonavala, Khandala, Matheran, Trimbakeshwar, Bombay, Pune, Nagpur, Melghat and Kinwat. These places except Bombay, Pune and Nagpur are well-known hill stations and receive heavy rains about 400 cm, or more.

The humidity in rainy season is 80—100 % and about 40% in other seasons. There are enough shady nitches to shelter them in Western Ghats. All these factors are highly conducive for the rich growth of liverworts and mosses, apart from other groups like Fungi, Lichens, and Ferns. About 70 mosses and 25 liverworts are known so far from Maharashtra. Many more would be found by intensive search at several suitable localities.

ORDER 1—SPHAEROCARPALES

Family : Sphaerocarpaceae

As already noted there are no representatives of this Order in Maharashtra, also in many other parts of India. But in the *Nal Sarovar* on the border of Saurashtra and Gujarat it occurs along or grows on wet mud at the margins of the lake. The only representative of this Order *Riella*, *Riella crossonixa* Traul is an aquatic member with two lateral overlapping lobes and a third dorsal lobe arising from the midrib. The life history of this interesting liverwort is worked out by Pande, Misra and Srivastava (1954) for the form called *Riella vishwanathii*, now considered to be the same as *Riella affinis*. The genus *Sphaerocarpus*

is primitive and is supposed to be formed of the prototype of the hypothetical ancestor of the Liverworts called *Sphaero-Riccia*. It has peculiar ovoid bottle-like involucres in which archegonia and antheridia are formed. *Riella* has a distinct twisted midrib. The reproductive organs are borne towards the growing point in the midst of lobes. The life history of *Riella* from Gujarat plant has been worked out by R. G. Patel 1977.

ORDER 2—RICCIALES

Family : Ricciaceae

This family is pretty common in the plains as well in hills at about 2000—3000 ft., but it could be found nearly up to 8000 ft. The genus *Riccia* is cosmopolitan, growing on moist soils in shady as well as exposed places. There are about 200 species of the genus in the world of which 30 occur in India. The genus is characterised by the absence of air pores and assimilatory chambers. It has spherical embedded sporogoni with a variable number of spores variable between 32—64, very often less. Antheridia are also embedded in thallus in special chambers. The thalli dichotomise once or twice. They could be monoecious or dioecious. The sex however in species has been shown not to be a reliable diagnostic character by Mahabale and Gorji (1947). In Maharashtra, the common species are *R discolor* L. et *L.* (=*R. himalayaensis* Kash.), *R. gangetiea* Ahmed., now separated from *R. himalayaensis* in part, *R. sanguiena* Kash. A winter species found on the river banks. Its thalli look red when mature. *R. frostii* Aust. considered by some synonymous with this species is found in the ditches along the rivers. It occurs commonly in plains on wet mud along rivers arising in the hilly Maval region of Sahyadris. The thallus begins as a male or female, but later the female thalli develop antheridia and become monoecious (Mahabale and Gorji, 1947). The thalli form rosettes, 12-13 mm large, deep green to red in colour. Male thalli are small, 2.5 mm. Sporophytes many, 10 or more, lodged in a row within the thallus dorsally. Spores brown, tetrahedral 45—60 mm. in diameter, with irregular reticulations. This species grows along sandy river banks after the floods subside at Nanded, Kopargaon, Pune, Ahmedabad. *R. fluitans* is a floating aquatic species, generally sterile. It grows in isolated or stagnant pools at high altitude in places like Mahabaleshwar. As the water in ponds dries up, it grows terestrially and produces sporangia.

The thalli of all species dry up in summer but some of them perennate by producing bulbils on the lower side under overlapping protecting scales e. g. in *R. discolor*. The margins of thalli curl upwards in dry months and are protected by the lateral purple scales. The theoretical importance of this genus lies in the fact that according to Kashyap (1919) and Goebel (1930) it is the last member in the reduction series in the evolution of liverworts starting from the level of *Marchantia* (See Pande 1932, Mahabale 1942). Its fossil spores have been discovered from the Triassic beds of Scana, Sweden by Miss Lundblad (1954).

Other common bulbiferous species are *R. billardieri* (=*R. himalayensis* and *R. bulbifera*). *R. billardieri* is a monoecious species with overlapping thalli 3-15 mm × 2.3-2.5 mm, anteriorly sulcate but rather flat dorsally. Its lobes at the apex are pyriform. The ventral scales are semilunar, purple projecting up to margin. The archegonia appear near the midrib and antheridia in front of them in special chambers

or cavities. Sporangia project from the dorsal surface posteriorly on the midline. The spores are dark red or brown 80—150 mm. in diameter, larger than those of *R. discolor*. They have 5—7 reticulations across the median diameter.

To the above list a new species has been added by Ahmed, *R. mangalorica* Ahmed, which is better known as *R. plana* Taylor. Its thalli are grey or light green, densely crowded. The sporophytes project vertically. Spore are pale or dark brown, tetrahedral 85—105 mm. in diameter with 8—10 reticulations on a diameter, spiny, the wing is 5-6. This is a flat species with more or less spongy thallus found on stone walls of bungalows and on compound walls in suburbs of Bombay, where the rainfall is about 90″.

The family Ricciaceae comprises three genera monotypic *Ricciocarpus natans* allied to *Riccia fluitans*. Both being aquatie, Riccia and *Oxymitra Ricciocarpus* and *Oxymitra* are not found in Maharashtra or in other parts of India.

1. *Riccia billardieri.*—The species is bulbiferous in *R. billardiari* forma *bulbifera*. It is a monoecious species with overlapping thalli, 3-15 mm × 2.3 mm, anteriorly sulcate, rather flat dorsally. Pyriform tubers appear at the tip. Ventral scales are semilunar, purple, projecting up to margins. Archegoina appear near the midrib in front of the autheridia in special cavities. Sporangia project on the dorsal surface posteriorly on the median line. Spores are red or dark brown, 80—150 mm. in diameter, larger than those in *R. discolor*. They have 5 to 7 reticulations across their median diameter. Triradiate mark is not prominent; wing absent. It is common on moist ground in August at Powai Lake, National Park, Bombay.

2. *R. discolor L. et L* — (*R. himalayensis* Kash.). This species is dioecious. It has large female thalli, 4-17 mm long; male thalli 3-6 mm. long; tubers apical or lateral. Ventral scales semi-lunar, deep pink, overlapping. Antheridial papillae present on the dorsal surface of the thalli, sulcate along the entire length. Sporogonia project dorsally in median row, spores dark brown 80—120 mm. in diameter with 5-10 reticulations across. Triradiate mark inconspicuous. The species is very common on moist soils at many places.

3. *R. frostii Aust.*—(*R. sanquinea* Kash.). The species is generally dioecious, but may become monoecious later as shown by Mahabale and Gorji (947). Female thalli 3 mm large, forming rosettes 13-2 mm. large, deep green to red in colour. Male thalli small 2.5 mm, red or pink. Sporophytes numerous in more than one row projecting dorsally. Sipores brown, tetrahedral, 45—60 mm. in diameter, with irregular reticulations; wing entire. This species grows in winter along the river banks after the floods subside, e.g. at Nanded, Kopargaon and Pune on banks of Mutha river.

4. *R. fluitans* L.—This is a floating species having green or yellowish green thalli. It is generally aquatic but when water dries up, it grows on wet mud terestrially. Terestrial form is fertile, Thalli have thin apical lobes. It is 12—15 mm long, 1.5-2 mm broad, with flat dorsal surface. Median ridge is prominent. Air spaces are large, 100—120 mm. long. Thallus is often spongy. Sporophytes lie in a single median

row, projecting ventrally. Spores dark brown, 76-80 mm. in diameter with 4-6 reticulations across. This species is found at *Dhobi* ghat at Mahabaleshwar. It also occurs at higher altitudes elsewhere, but always in isolated ponds.

5. *R. plana* Taylor (= *R. mangalorica* Ahmad). Thalli gray or light green, growing densely crowded; dorsal surface concolor. Thalli are very broad. Sporophytes project ventrally. Spores pale brown or dark brown. Tetrahedral 85—105 mm. in diameter with 6-10 mm. reticulations across, spiny, wing 5-6 mm. The species is rather flat, more or less spongy. It grows on stone walls of houses, compounds and bungalows where the rainfall is high, e.g. in Bombay Suburbs.

ORDER 3—MARCHANTIALES

Family-Marchantiaceae

The next Order of liverworts is Marchantiales. It is a large Order comprising 26 genera and about 400 species all over the world. In India 23 genera have been reported. They are generally found at hill stations, but some also occur in plains.

The genus *Marchantia* does not occur in Maharashtra but is abundant at Panchmadhi, Ootacamund, Srirangpattan etc. The following Marchantiaceous plants are found in Maharashtra :—

1. *Asterella angusta* Beauv. (*Fimbriaria anguata* St.) :

It is very common in rainy season on the calcareous walls. The thalli 20 mm. × 3 mm, are dioecious and bear sporophytes on upraised archegoniophores on the dorsal surface towards the apical region. Male receptacles are I-cushion-shaped, sessile. They lie dorsally on separate thalli.

2. *Plagiochasma* L. et L :

An unnamed species similar to *Conocephalum* is occasionally found in Mahabaleshwar, Melghat ; needs investigation. It could be *Plagiochasma* sp. (?).

(*i*) *P. appendiculata* L. et L.—This is rather uncommon in the State but common at Mount Abu, Panchmadhi etc. It bears stalked male and female receptacles separately but on the same plant. Female receptacle lies generally behind the apex of the thallus, and behind it lie on the same thallus male receptacles as upraised v-cushions Sporophyte round. Spores yellowish, 52—90 mm. with reculate lamellae, 2-3 across a diameter.

(*ii*) *P. articulatum* Kash.—The thallus in this species grows in a continuous articulate manner, becoming progressively smaller towards growing point. Thalli are semilunar each arising from the apex of the lobe one behind. Apex is notched. They are monoecious and bear sessile upraised male receptacles and surrounded by small scales behind the female receptacles raised on stalks at the articutation. This species is very abundant at Panchgani and other hill stations in the Western ghats. Spores are yellowish, reticulate, lamellate, 60—80 mm. in diameter including the wings.

(*iii*) *P. simlensis* Kash.—This species occurs in low hills between Pune and Mahabaleshwar where it is sterile. It has thicker, 15 mm long and 4 mm broad thalli, but most of them are sterile. However in Melghat they are common and fertile. This species reaches its extreme southerly limit in Kodiakanal. It is quite common in N. W. Himalayas, Simla and Nepal,and is also found in Vindhyas at several places.

3. *Targionia* L. *Targionia hypophylla* L :

This common liverwort is found at many places. It has peculiar habit of burying the soil apical sporophyte—which is like a small button. Hence the specific name. It is produced near apex of the thallus and is covered by overlapping pink scales. The thallus is 10—15 mm. long and 2—4 mm. broad. It may be monoecious or dioecious. Apex of thallus seldom dichotomises. The pale green thalli occur singly. Antheridia are borne on adventitious lateral branches arising ventrally from thick midrib. Female receptacle is borne near the apex but soon turns down and becomes hypophyllous. Antheridia aggregate on short ventral shoots. There are 5-6 mm. archegonia on each thallus. Spherical capsule is geophilous. Spres 30-40 mm.elaters are prominent, large 140—180 mm. It generally grows in moist shady places. It has deep green overlapping thalli stuck to soil by the base only. It is very common at hill stations such as Mahabaleshwar, Panchgani, Bombay hills, Khandala, Melghat etc.

4. *Cyathodium* Kunze :

Cyathodium is a small genus generally growing in caves and shady tunnels. Thalli very thin, transparent, yellowish green in colur. *C. tuberosum* Kashyap and *C. barodae* Chavan are two common species.

(*i*) *Cyathodium tuberosum* Kash.—The species is dioecious dichotomising once or twice. The thalli are very thin, and have highly overlapping hyaline scales ; lobes oblong ; male plants less branched ; female plants linear oblong, fan-shaped with upraised margins ; the dorsal surface flat. Ripe sporogonia are prominent on the thallus. Male receptacles lateral and cushion-shaped. Spores 40 mm. in diameter, elaters spiny, 17 to 30 mm, trispiral. Vegetative propagation is common by means of tubers which arise apically or from any portion of the midrib on the lower side.

(*ii*) *Cyathodium barodae* Chavan.—This is also common in some plains in shade or in open areas especially at Mahabaleshwar, Baroda and elsewhere. The name is given by Prof. A. R. Chavan (1937) who first described it from Baroda. The species grows on the brick and concrete walls with *mosses*, *Riccia* and *Notothylas*, exposed only sometime to sunshine on eastern side, but grows in shaded areas. The plants are delicate, yellowish green, 3-5 mm up to 10 mm, very thin with simple thallus. Air chambers prominent. Adventitious branches are not found in this species as in *C. tuberosum*. Antheridial receptacles lie near the margin on any part of thallus, but close to the archegoinal receptacle. Sporogonia 0.5—0.70 mm. long. Spores dark brown, spiny 48 mm. long. Elaters 9-10 mm. in a capsule, trispiral. According to Schiffner *ex*. Proskauer (1951) this species is Synonymous with *C. smaragdinum*. Recently Ram Udar has found another species of *Cyathodium* from Mahabaleshwar.

5. *Exormotheca* Mitten :

(*i*) *Exormotheca tuberifera* Kash.—This species is monoecious, but other species of it may be dioecious. It produces short thin tubers from the apex towards the end of rainy season and is propagated by them. The growing plant and tubers are surrounded by minute purple scales. The tuber is full of starch. The thalli dichotomise twice or thrice. Lobes are long, linear, firmly attached to the substratum, 12 mm, green with

deep narrow conspicuous dorsal groove. Ventral surface covered with purple or hyline truncate sulcate scales. Antheridia lie in depression behind the stalk of the female receptaclc along the midrib in the median groove. Antheridial papillae are red. Female receptacle arises from a pit at the fork of two lobes. The stalk is 10 mm long. The receptacle hemispherical ; capsule is fully exerted, directed upwards. Spores tetrahedral with conical papillae on the convex side. Elaters 120—140mm. with 3 or 4 spirals.

This species grows in dry situations on the slopes of rocks near water falls and in the crevices of rocks. It grows in rainy season and aestivates in dry months, but regenerates again next rainy season by means of tubers. So far it has been known from Katraj near Pune, Sinhagad and Mahabaleshwar.

6. *Cryptomitrium* Austin

(*i*) *Cryptomitrium, himalayensis* Kash.—This small yellowish green monoecious liverwort is cxtremely delicate; lobes 6×6 mm long quadrate, margin irregularly crenate. Female receptacle stalked, one on each lobe of the fork. Stalk deeply grooved, 6-8-ridged. Receptacle thin, sporogonia 1-3; spores brown, 50-60 mm. tetrahedral, broadly reticulate lamellate on the convex side. Receptacle 2-3 mm in diameter, elaters 350-400 mm. long, closely trispiral, generally green in colour. The plant grows in moist places under dense shade of trees. It is reported from Trimbakeshwar near Nasik and from Mahabaleshwar growing on shady hill sides. According to Stephani (1898—1908), this liverwort is often confused with *Cyathodium tenerum*. At the end of the rainy season apical portion becomes thick and is marked off by the formation of a oncentric purple band on the hinder side. Portion of the thallus beyond it dies and the anterior portion towards apex survives and regenerates into a new plant next season.

ORDER 4—JUNGERMANNIALES

This is the third Order of liverworts. It is closely related to Marchantiales. They are small thalloid plants, leafy, in most members, except in the family Codoniaceae which are fleshy and thallose. They have leafy axis as a rule, but may be absent.

The rhizoids are always smooth-walled. The leaves appear to have been arranged in two lateral rows on the central axis or midrib, but there is always a third row of leaves below the midrib modified into mucilage glands, water glands or amphigastria etc. Capsule is long stalked and dehisces by four valves.

The Jungermanniales are generally classified into 3 families. Haplomitriaceae, Jungermanniaceae and Metzgeriaceae. Haplomitriaceae does not occur in Maharashtra. The plants belonging to other two suborders or families are distinguished by the presence of archegonia at the apex of the thallus or by absence of them, there as : (1) Acrogynae, and (2) Anacrogynae. In the latter, they are borne on the dorsal surface of the prostrate shoot; but the apical cells are not utilized for the production of the archegoina as in the former. There are about 190 genera and 8,000 species in this Order. It is the largest Order among the Hepaticeae.

ACRDGYNAE

Frullania squarrosa Nees (Family-Frullaniaceae) :

This is an epiphytic liverwort common at high altitude with considerable rainfall. It has 2-3 forms. The leaves lie in 2 lateral rows on stem; the leaves on lower 3rd row are converted into amphigastria. Archegonia are terminal and clustered. Different authors have reduced different species from various areas to *F. squarrosa*. So far it is known from Khandala and Mahabaleshwar. The plants are dioecious and epiphytic. Sometimes thcy grow on soil near tree trunk also.

Lejeunea sp. (Family-Lejeunaceae) :

Plants are small dioecious growing on moist rocks, or bark of trees and on decayed leaves in soil. Leafy lobes are overlapping, distichous, oblique, slightly convex on the dorsal side; ovate oblong 0.5×0.3 mm long. Margin is entire. Amphigastria are large compared to stem, suborbicular, flat and with a branch in about 4 pairs. Perianth obovate beak conspicuous. Ventral leaves are with 2 or 3 small keels. Plants producc dark capsules on a short stalk. It is common at Londha, Castle Rock and hill stations adjoining them in Maharashtra.

Leptocolea lanciloba St. (Family-Lejeunaceae) :

This is an epiphyllous liverwort found in high humid areas on the leaves of *Cinammomum tamala, Syzygium cumini* near water falls, or in high shady evergreen forest trees. Many plants grow on the leaves and complete their life cycle on the leaf itself. The plants are minute 2-5 cm long forming dense network on the smooth upper surface of the leaves of host plants. Their lobes are overlapping, succubous, with numerous amphigastria. Plants are monoecious, producing 8-10 autheridia on small lateral branches. Archegonia are borne on the other branches around the axis in the axils of leafy lobes, each bearing a single archegonium. Capsules are borne in the axils of leaves on erect lateral branches. Plants dry up in summer but do not die.

Small multicelled gemmae arise from any cell at the margin of the thallus lobes and produce new plantlets, propagating the species vegetatively (Mahabale, 1970). They grow overlapping each other.

Radula complanata (L) Dum. (Family—Radulaceae) :

The gametophytes arc very thin, pale, yellowish green or white, attached to the bark of trees like mango and grow with other mosses and liverworts. Stcm 2 cm long, with pinnate branches; leaves imbricate, inserted by broad base, spreading, quadrate or suborbicular 0.75×0.5 mm. margin entire, apex round. The gemmae arc formed marginally. They are multicellular. The species is found at Khandala and Mahabaleshwar.

ANACROGYNAE

Fossombronia himalayensis Kash (Family Codoniaccae) :

This small liverwort has leaves apparently radially arranged. When growing erect it looks like the head of a cauliflower. Plants grow in compact clusters on moist soil in exposed places. Thalli 8 mm, light green in colour. They have elongated axis and midrib on which bilateral leaves converge. Plants arise either from the spores or from tubers. The species is monoecious and protrandrous. The growing point lies

horizontally in the midst of young leaves and is encircled by mucilagenous hairs. Antheridia and achegonia develop acropetally dorsally, singly or in groups. Archegonia generally lie in the immediate vicinity of the growing point. Sporophyte globose, exerted on a transparent short seta, dehiscing by the separation of apical part of the capsule into four valves. Spores 40-50 mm, brown with furcate lamellae, sometimes, with a few reticulations. Elaters loosely bior trispiral, 100—140 mm long. Tubers produced apically are sessile or stalked. It is allied to *Sewardiella* (See Pande, Mahabale, Raje, and Srivastava 1954) and is found on moist ground in many places.

Petalophyllum Gettsche (Family—Codoniaceae) :

Petalophyllum indicum Kashyap.—This is a rare liverwort found only at the citadel of Purandar fort (District Pune). Plants dioecious, 3-4 mm long, 7 mm broad, basal portion cylindrical and winged. Wing many-layered at the base, becoming one-layered anteriorly. Midrib distinct. Antheridia lie in groups behind the apex, covered by scales. Archegonia in groups of 4—7 on the midrib, protected by a bell- shaped perianth. Sporogonia generally one in each perianth. Seta variable in length, 10—25 mm long, capsule spherical, 2 mm in diameter, dark brown. Spores dark brown, round 40 mm in diameter with a wavy margin, reticulate black, with 3—4 pentagonal or hexagonal, reticulations on median diameter, 8-10 mm each. Marginal wing 14-17 mm. Elators 280-400 mm long, 8—10 mm broad, rarely branched, attenuated towards both ends.

Aneura Dum. or *Riccardia* S. F. Gray (Family—Aneuraceae) :

A. indica St. (Ms.).—This liverwort is very common on wet soil in marshy places along puddles, flowing water courses etc. *e.g.* at Pashan lake near Pune. Plants dioecious. Thallus fleshy, pinnatly branched with a broad midrib. Male plants more thick, less circular; female plants very short at the margin and has short branches in 2—8 series, perianth. absent. Calyptra large, cylindrical having papillae at the apex. Capsule pedicellate, oblong, opening up to base by 4 valves. Spores small, 20—30 mm, lamellate, elators 190 mm. long, monospiral. The species often grow in moist places in small patches usually singly.

Pallavicinia : (Family—Pallaviciniacea) :

Pallavicinia longiseta.—Plants dioecious, thalli overlapping, thin, 20—25 mm long, with very distinct midrib and thin wings. Male thalli producing antheridia dorsally on the median line. Female thalli produce archegonia near the apex. Sporophyte has a long transparent seta about 2-3 cm long. Capsule avoid, conical, brown in colour, irregularly formed. Elatophore distinct, spores opaque. This is one of the handsome liverwort supposed to be a prototype of early fossil liverworts especially the Jungermaniales.

Metzgeria Reddi (Family—Metzgeriaceae) :

Metzgeria pubescens Reddi.—Plants dioecious, generally sterile forming large interwoven patches on margins of rocks, partially immersed in water and partially outside. Yellowish green upto 50 mm long, 2 mm broad, irregularly branched, distinctly dichotomous. Branches have hairs only on the posterior surface. Branches of female plants have bristles on both surfaces; midrib subterate. Plants often grow without capsule vegetatively. It is common at Castle Rock and adjoining high hilly areas of Maharashtra on wet rocks with trickling water.

ANTHOCEROTOPSIDA

Order : ANTHOCEROTALES; (ANTHOCEROTAE)

This order comprises highly advanced liverworts popularly known as "Hornworts". They are considered to be an intermediate group between the liverworts and pteridophytes such as *Equisetum* or *Psilophyton* But the small number of chromosomes in liverworts and very high number of chromosomes is *Equisetum* has forced to abandon this once favourite idea. The group is considered to have 6 genera. *Anthoceros, Aspiromitus, Phaeoceros, Megaceros, Dendroceros* a Malayan genus and *Notothylus*. Another new genus *Folioceros* has been added to these by Bharadwaj (1971). *Dendroceros* and *Megaceros* do not occur in Maharashtra. The genus *Aspiromitus* is now considered to be mere section of the large genus of *Anthoceros* by Proskauer (1951). Bharadwaj (1971 onwards) has published many papers on this group.

There are two types of spores in *Anthocarotales* and 3 types of elaters. Spores may be black, purple black or yellow. The elaters may be simple, with or without spirals, unicelled or multicelled and septate, single-celled ones may be simple on vermiform. Columella in the sporophyte may be present or absent. They all have *Nostoc* colonies within the thallus. The new genus *Folioceros* Bharadwaj (1971) has elaters which are multiseptate unevenly thick walled, beaded, and very distinct and different from those in all other genera of the Anthocerotales.

Anthoceros L.—They have fleshy highly flaccid thalli due to their cells having been filled with mucilage. The species may be monoecious or dioecious.

Anthoceros erectus Kash.—The plants are dioecious growing in dense clusters on damp soil. Thallus thick, fleshy, dark green raised on a thick stalk-like structure, expanding above into a more or less cup-like body, either ascending or prostrate, fan-shaped, deeply lobed, 10 mm, broad male plants, 5 mm, long and 0.8 mm, in diameter. Capsul slender, acute, its wall cells filled with mucilage. Spores black, granulose, 30—40 mm. Pseudo-elaters about 121 mm. thin walled, simple or branched. This species is very common at higher altitudes in the western ghats growing annually.

Besides this species, two or more forms of *Aspiromitus dixitianus* occur at Khandala.

Anthoceros has two types of spores, some species have black or purple black spores. They are now put under the taxon *Anthoceros* and the others with yellow spores have been put under a new genus *Phaeoceros* formed by him. Accordingly *Anthoceros himalayensis* Kash. with yellow spores has become *Phaeoceros himalayensis* Praus. The rare genus *Aspiromitus* has worm-like elaters, generally simple. It is now put under the section black spored species of *Anthoceros* as a separate section *Aspiromitus* having vermiform, non-septate elaters (see Mahabale 1941; Prauskaur, 1968; Bharadwaj 1971).

Aspiromitus consists of one or two celled septate vermiform elaters and black spores. Thallus is convernus and has 40 mm. dark echinate purple spores. On account of single unbranched vermiform elaters it is called *Aspiromitus*. They were segregated by Stephani (1898-1908)

into that genus. *Aspiromitus dixitianus* Maha. from Khandala was described by Mahabale (1941). It has now been transferred to the dark spored section of *Anthoceros*, with vermiform elaters called *Aspiromitus*. It is dioecious. Male thalli 1-1.7 cm long, erect, lobes cunate and furcate, unequal. Male thalli smaller than female thalli bearing numerous antheridia in each chamber 30 or more. Female thalli 2-3 cm long, broad semi-erect, dark green or yellowish green in colour, capsules 1.5-2 mm long, stout, stomatiferous, spores dark black, 40 mm in diameter, elaters many, 100-150 mm long, smooth simple 1 or 2 septate, unbranched, deep purple or black in colour. *Aspiromitus* is very common at Khandala, Reversing station (C-R) Londha, Castle Rock etc.

Phaeoceros :

The yellow spored species of *Antheceros* now are separated by Proskauer (1951) into a separate genus *Phaeoceros*. *A. himalayensis* Kash has become *Pheoceros himalayensis* (Kash). Pros.

P. himalayensis (Kash.) Proskauer.—Plants dioecious, closely attached to the substrate, light green. They form large patches, thallus linear oblong having tubers at the margin, male plants small, less divided than female plants. Female plants large, circular upto 20 mm in diameter deeply lobed, their margins overlapping, involucre often in pairs, cylindrical, capsule long, 30 mm, not stout, columellate. Spores yellow, tetrahedral, thin, with small rounded papillae on the convex surface 25 mm Pseudoclaters thin-walled, branched or simple 10 mm broad. It grows sparse at Lonavala but is abundant at Mahabaleshwar near Lingmala Falls.

Notothylas.—The genus has about 12 species in temperate and tropical regions. Of these four species *N. indica*, *N. levieri*, *N. chaudhurii* and a yellow spored species of it, reported by Prof. Mrs. Kusum Gupte from Pune, known as *N. poonenis* Gupte.

The thallus in *Notothylas* is repeatedly divided into a rosette of lobes. Antheridia lie in swollen chambers, 2-4 in each. Involucre short, capsule marginal, conical or spindle shaped, with a large round foot, dehiscing by two valves, stomata absent. Columella present in the centre or may be absent. The capsules fusiform, many, on a thallus. Spores large, tetrahedral with their convex side papillose. Elaters stout, large in size than the spores 30-35 mm. Spores yellow or dark brown or purple; elaters with spiral or simple oblique bands.

N. indica Kash.—It is a columellate species 120 x 18 mm at the median diameter. Spores opaque, dark brown 36mm Pseudo-elaters with bands, 40 mm x 20 mm This is essentially a species of the plains.

N. levieri Schiff. (M. S.).—This species is noncolumellate, dioecious; plants large, circular in outline, upto 15 mm. Capsule 160 x 10 mm. Spores opaque, dark brown, minutely granulate, 36 mm; sterile cells oblique, curved with thin bands or incomplete spirals. The entire endothecium of it forms archesporium while the whole of amphitheium forms the wall of the Capsule.

N. chaudhurii Nirula.—This species is common on moist ground in rainy season at Nagpur, Yeotmal etc. It is sometimes columellate and sometimes non-columellate as the other species.

Notothylus sp.—Similar to *N. poonensis* Gupte having yellow spore grows at Dharwar, Kalhattigir (Karnatak) etc. It is a small one growing in rainy season. The thalli are circular monoecious, much lobed at periphery, lobes over-lapping, brown attenuated obliquely towards margin, singly or in pairs. Capsules protrude from the ventral side of the thallus. Spores golden yellow, smooth-walled, 42 u in diameter columlla present; sterile cells not differentiated. Possibly it is a form of N. poonensis.

BRYOPSIDA

Musci or Mosses

The second group of Bryophyta is Musci or mosses. These are small plants having gametophyte in two phases: (1) The algal-like phase protonema, and the second phase, (2) the gameto-phore or the moss plant proper, arising on it as a bud. The plants consist of erect stem with leaf-like organs, the so-called phyllods. It bears gametangia or reproductive organs and then appears sporophyte on it. Musci is a large group of small plants growing either erect or creeping. They grow on soil or on trees. Generally a little soil gets collected on bark, the bark gets decomposed and is colonised by Cyanophyceae, Mosses succeeds them and form close stands. They all are homosporus and produce antheridia and archegonia either on the same plant but never together, grow either on separate plants or on different branches of the same plant. Thus they are monoecious or dioecious. In monoecious mosses, the antheridia are formed terminally in large numbers and constitute the so-called moss flower. These then are mixed with sterile multicelled out-growths called paraphyses. Archegonia are borne terminally on separate branches, arising from below the antheridial branch. In dioecious species male and female plants bear either antheridia or archegonia separately.

In some mosses archegonia arise singly in the axils of leaves or lie one below the other acropetally as in *sphagnum*. After fertilization the sporophyte arises as a stalked plant having a bulbous foot, a long stalk or the seta terminating in a capsule. It opens variously by means of an operculum and peristome. Moss capsule is green having photosynthetic tissue and air spaces in it. There is a columella in the middle, around which the spores develop. They are numerous and green or dark brown. There are no elaters in the moss capsule unlike those in the capsule of Hepaticae.

All mosses, like liverworts, are homosporous. There being no heterosporous moss; Spores are liberated periodically by hygroscopic movements of the peristome teeth. And dispersed by wind. On germination they produce alga-like protonema on which the gametophyte arises.

Classification of Mosses

There are about 660 genera and 14,500 species. They are generally grouped into three Orders.

(1) **Sphagnales.**—These are aquatic mosses growing perpetually from the terminal portion. Their hinder part dies and forms peat ; One genus and 336 species ;

(2) **Andreaeales.**—They grow in extreme xerophytic conditions on hard rocks or in their crevices under hot or cold conditions ; 2 genera and 120 species;

(3) **Bryalyes.**—This is the largest sub-class of Mosses having 80 families, 675 genera and 14,000 species included in 15 Orders.

(1) **Sphagnales.**—These are peculiar mosses growing under water producing thalloid protonema unlike other mosses. They are much branched, erect, with leafy gametophore. It has axillary archegonia and antheridia borne singly in a leaf axil. Sporophyte has an additional false foot below the true bulbous foot, called pseudopodium. Capsule has circumscissile dehiscence and spores are arranged in a crescent shaped cavity, not found in the Maharashtra.

(2) **Andreaeales.**—They have creeping protonema and a small oblong capsule breaking ventrally from top. They are also not found in Maharashtra.

Both Sphagnales and Andreaeales are found in the Eastern Himalayas, Assam, in places like Darjeeling, Kalimpong etc.

(3) *Bryales.*—These have 80 families out of which 25 occur in Maharashtra. The largest family of it has stem with a central conducting column of elongated cells, the Polytrichales. The classification of mosses generally followed is that of Dixon (1932) modified to a small extent by later authors like Bruhl (1931), Brothenus (1924—1928), Steere (1958), Chopra (1974). The following paragraphs give the list of common mosses found in Maharashtra in various habitats. In all about 65 species have been reported. Some of them are highly selective in their substratum and grow as mixed community in which 2 or 3 kinds of mosses grow together or they grow as pure strands of a singly species. The list of moss communities and their growth forms are given below :

Mosses growing gregariously together are *Anoectangium stracheyamum, Anomobryum auratum, Pohlia flexuosa, Bartramidula bartramioides, Bheterophylla, Philonotis* sp., *P. Sacunda.*

Mosses growing in unmixed strands

The mosses given below grow generally in pure unmixed strands : *Hyophyla involuta, Hydrogonium consanguineum, Semibarbula orientalis, Physeomitrium, Coorgense, Funaria hygrometrica, F, nutans, Gymnostomiella vermicosa, Splachnobryum indicum, Bryum, coronatum.*

Mosses are green, dark pale green or yellowish green in colour and can be recognised by it. They are very often indicative of the substratum on which they grow. Their growth forms are given below.

Habitatwise Classification of Mosses

(A) *Mosses growing on humus rich soil* :

The following mosses are generally found on humus rich soil more or less acidic e.g. *Pogonatum aloides,* forma *neesii, Fissidens bryoides, Fissidens zollengeri, F. splaerobryoides, Garckea phascoides, Plerochaete squarrosa, Brachymenium acuminatum, Bryum wightii Bartramidula bartramoiodes, Leucodon secundus, Thuidium cymbifolium, Rhyncho stegiella humilis, Vesicularis reticulata.*

(B) *Mosses growing on forest floor*

Following mosses grow on forest floor containing a lot of leaf debris.

Brachymenium exile, *Bryum wightii*, *Diaphanodon procumbens*, *Petrobryopsis walkeri*, *Meteriopsis reclinata*, *Pinnatella calcutensis* *Symphydon angustus*, *Entoden* sp., *Streaophyllum tovoyense*, *S. anceps*, *S. lingulatum*, *Glossadelphus*, *vivicolor*, *Bryosedgwickia kirtikarii*, *Eutropothecium cyperoides*, *Vesicularia reticulata*.

(C) *Mosses as indicators of underground deposits*

Some mosses are highly indicative of the elements on which they grow; e. g. mosa, *Marseva* grows on soils above the copper deposits and is indicative of copper in the substratum. Some grow on lateritic soil rich in iron or aluminium. The soils at Khandala, Mahabaleshwar, Panhala, Amba are lateritic, and quite rich in oxides of Aluminium. *Pogonotum aloides*, forma *nessii*, *Funaria hygrometrica*, *Brachymenium acuminatum*, *B. exile*, *Bryum ghatense* grow on lateritic soil and show extreme xerophytic adaptations due to excessive iron in them.

(D) *Mosses on peaty soils*

Brachymenium turgidium, *B. nepalense* grow on peaty soils, but not on very acidic soils.

(E) *Mosses growing on calcareous soils*

The following mosses, on the other hand, are calciferous and prefer alkaline soils e. g. *Hydrogonium consanguineum*, *Semibarbula orientalis*, *Gymnostomiella vernicosa*, *Splachnbryum indicum*, *Bryum coronatum* etc.

(F) *Mosses growing on exposed rocks and similar dry situations* :

A peculiar feature of hill stations like Khandala, Mahabaleshwar, Chikhaldara is that they receive heavy precipitation, in four months from the middle of June to end of October, but for the rest of the year, particularly in summer months there are no rains. The mosses growing on exposed rocks and in ledges get completely dried up. A similar situation exists at many places where mosses grow. In such a place mixed associations of mosses *Hyophila involuta*, *Anomobryum auratum*, *Pohlia flexuosa* *Bryum coronatum*, *B. ghatense*, *P. secunda*, *Bertiamirula artramiodes*, *B. roylei*, *Philonotis hastata* come up. They have varied degrees of tolerance to desiccation. Generally two or three of them grow together in one place.

(G) *Mosses of high humid places* :

A few grow under conditions in which mangroves grow. The mosses that grow under extremely favourable conditions of high humidity produce bulbils by which they propagate vegetatively. Some of them hang from the branches of trees suspended like festoon chains. This group of mosses growing epiphytically on the bark of trees regenerates quickly with the onset of monsoons with high humidity as in Western ghats; but they get dried up completely after January. They form long, pendulous chains hanging from tall trees and engulf their branches. Sometimes the whole tree looks decorated with mosses such as *Diaphanodon procumbens*, *Materiopsis reclinata*, *Pinnatella calcuttensis*.

Some mosses take their nutrition from the decomposition of bark, e. g. *Macromitrium sulcatum*, *Levierella fabroniacea*. Others collect some soil by their entangled rhizoids and grow in it. e.g. *Brachymenium turgidum*. Some from compact cushions feeding partly on the debris

and partly on soil accumulated on the bank e.g. *Octoblephaum albidum*, *Campylopus goughii* etc. No moss was found epiphyllously like some leafy Jungermanniales like *Coleolejunea* sp. or *Leptoeclea lancilobs.* Some mosses grow well at a great height of tall trees like *Holigarnes grahani*, *Grevillea robusti*, at 10-12 m high e. g. *Macromitrium sulcatrem*, *Pterobryopsis walkeri*, *Meteoriopsis reclinata*, *Stereophyllum tavoyensis*, *S. anceps*, *S. lingulatum*. They were not seen at lower heights on the same trees. A unique moss, *Calymperos tortelloides* grows on the branches of *Mangifera indica*, *Anacardium occidentale* growing by the sea coast at Bombay, Thana, Borivali, Kankeshwar, Uran etc. It also grows on the trunks of palms like *Borassus flabellifer* *Cocos nucifera* and *Areca catechu*. It however, does not grow on the same trees in the ghats or elsewhere away from the sea coast. It propagates by gemma formed at the top of leaves.

(H) *Aquatic mosses* :

Some mosses grow partially in water or under water attached to rocks below e. g. *Fissidens sedwickin*, which grows under water in rocky stations at Lingmala, Mahabaleshwar and at Matheran. *Fissidens grandiformis*, *Mnium rostratum* also grow in water.

Mosses growing in marshy places.—The following mosses grow in marshy places. *Pogonatum aloides forma neesii*, *Fissidau-splachnobryos ides*, *F. bryoides F. walkeri. Phgomitrium coorgense*, *Funaria (Entosthodon) natans.*

(I) *Mosses as indicators of high humidity* :

A special feature of the climate of Mahabaleshwar is extreme humidity above 90% in rainy season. It is highly conducive to the growth and regeneration of mosses. There are *Calymperes thwaitesii* *Macromitrium sulcatum*, *Diaphanodon procumbans*, *Pterobryopsis-walkeri*, *Meteoriopsis reclinata*, *Pinnatella calcutensis*, *Symphyodon angustus*, *Entodon plicatus*, *E. prorepens*, *Levierella fabroniacea Stereophyllum tavoyanse*. These mosses indicate high humidity in climate.

(J) *Mosses restricted to cold climate at high altitude* :

The following species grow at high altitude at Khandala and Mahabaleshwar. They have restricted distribution due to cool climate. They may be taken as indicators of climate at certain altitude in western ghats because they are not found in plains down : e. g. *Bryum ghatense*, *B. wightii*, *Macromitrium sulcatum*, *Diaphanodon procumbens*, *Pterobryopsis walkeri*, *Pinnatella calcuttensis*, *Symphydon angustus*, *Entodon*, *plicatus*, *Entodon prorepens*, *Levierella fabroniacea*, *Stereophyllum tavoyense*, *S. auceps*, *S. liqulatum*, etc.

On the other hand, *Fissidens splachnobryoides*, *Fissidens bryoides*, *F. zollingeri*, *Octoblepharum albidum*, *Hyophila involuta Erpodium*, *mangiferae*, *Stereophyllum tavoyense*. They tolerate varied climatic conditions and are climatically cosmopolitan.

(K) *Xerophytic Mosses* :

Funaria hygromectrica, *Physeomitrium coorgense*, *Pogonatum aloides*, *Semibarbula indica*, *Hydrogonium consanguineum*, *Funaria nutans*, *Bryum ghatense*, *B. coronatum*, *Plachaobryum indicum*, *Gymnostomiella vericosa*. These mosses grow under very dry conditions.

(L) *Cosmopolitan Mosses* :

Species like *Funaria hygrometrica*, *Octoblepharum albidum*, *Fissidens bryoides*, *Hyophila involuta*, *Semibarbula orientalis*, *Gymnostomiella vernicosa*, *Bryum argenteum* are cosmopolitan. They are found all over the world and they indicate no region, soil or climate. They tolerate a variety of conditions, and therefore, no conclusion can be drawn as regards the habitat of such species.

(M) *Endemic mosses* :

Pogonatum aloides (Hedw.) P. Sesuv. forma neesii (C. Muell) Gang. a new record from Mahabaleshwar and is endemic. *Archidium birmannicum* Hitt. ex. Dix. on moist ground at Khandala is a new record. Following terrestrial mosses are new records from Mahabaleshwar having restricted distribution. *Archidium indicum* C. Muell, *Fissidens splanchnobryoides* Broth, *F. bryoides* Hedw., *F. curvatoxiphiodes*, *Pleurachaete squarrosa* (Brid.) Lind., *Hymenostylium recurvirostre* (Hedw) Dix., *Hydrogonium consanguineum* (Thwait et. Mitt.) Hilp., *Semibarbula orientalies* (Web.) *Wijk.* et Marg. *Anomobryum surateim* (Mitt.) Joeg., *Pohlia flexuosa* Hesk. Some of the New records of terrestrial mosses at Khandala are *Funaria* (*Entosthodon*) *natans* Mitt., *Anoectangium stracheyanum Mitt.*, *Rhynchostegiella humillima* (Mitt.) Broth. Epiphytic mosses occurring at Khandala and Mahabaleshwar are as follows :—

Fissidens minutus wait et Mitt Campylopus goughii (Mitt) Jaege *Campylopus gracilis* (Mill.) Jaeg., Mahabaleshwar are other terrestrial mosses. *Brachymenium nepalense.* Heok, *Bryum ghatense* Broth. ex. Dix. *Bryumi coromatum* schwaeger, *Bryum argenteum* Hedw, *Leucodon secundus* (Harv.) Mitt., *Thuidium cymbifolium Dos.* et Molk, *Rhynchostegiella humillima* (Mitt.) Broth., *Entoden prorepens* (Mitt.) Jaeg., *Glossadelphus urbicolour* (Broth. et Dix.) Broth., *Bryosedqwickia kirtikarii* Card. and Dix. *Ectropothecium cyperoides* (Hook.) Jaeg are epiphytes at Mahabaleshwar.

The species *Poleurochaete squarosa* (Brid.) Lindb. *Dicranodontium didictyon*, *Leucodon secundus*, *Glossadelphzus tolingeri* were supposed to be rare but they have been found in Western India now.

A classification of mosses based on ecological considerations has been given by Gams (1932) in Verdoorns *Manual of Bryology* Bt. XII pp. 322—366, 1932 and hence not repeated here.

Geographical Distribution of Mosses

In point of geographical distribution some mosses like, *Funaria* are cosmopolitan. Others have restricted or regional distribution and still others are endemic. The paragraphs below enlist them separatcly.

Mosses in India are concentrated in four regions viz., Eastern Himalayas, Western Himalayas, Western Ghats and Eastern ghats. A part of Western Ghats are in Maharashtra. Some genera and species extend right down southwards upto Nilgiris and Kodaikanal, and some are concentrated in N.-W. Himalayas and some in Eastern Himalayas. Khandala, Mahabaleshwar in Maharashtra are only typical examples of places where rich moss flora occurs. They need to be surveyed.

Mosses as a class are the only colonisers of land from aquatic habitat. Very few mosses are found in early times. But in quaternary period

they are abundant. They are known as *Muscites* and range from upper carboniferous to Pleistocene. Several members of Sphagnales are known to form peat bogs. They are very rare in the Mosozoic period, but some do occur in the Triassic of Natal, Cretaceous of Greenland, North America etc. Some members of Polytrichales are known from the Miocene period and species of *Muscites* from the Oligocene of Victoria, Australia. In many peat deposits they are in the state of imperfect fossilization, but are not fully fossilized. They really are the sub fossils. In Maharashtra there are very few peat bogs and no fossils of mosses have been found in them.

CYTOLOGY AND MOSS POPULATION :

Mosses generaly grow in good number of individuals in various populations. Although they look alike morphologically there is a difference in their haploid and diploid colonies. Mosses are known to have polyploid as well as anupoloid colonies and races with inter and intra specific polyploidy occur, of which intrapolyploidy is more common, abount 12%. The exact status of interspecific polyploidy is difficult to determine. Out of 1120 mosses of which the chromosome numbers are known, 285 mosses have intraspecific polyploidy. The percentage of polyploids is highest in Ukranian region of U.S.S.R. where the highest number of polyploid mosses are known, about 45%. The lowest polyploid mosses are found in India. Some specific examples are *Entoden* 22 and 33, *Brachymenium* 11 ano 22, *Tortula* 13, 14 and 25, *Hyophyla* 7 and 13 and *Pohlia* 11 and 22. Polyploidy is generally brought about by a change in chromosome number and sexuality. There are varied base numbers, 6, 8, 9 in mosses, is common in Indian mosses. The ratio of sexes in mosses is not determined. The haploid mosses are generally dioecious and diploid monoceious. Dioecism is supposed to be due to preferential pairing of sex chromosomes. Polyvalent chromosomes are also known.

Anuploidy occurs in *Bryum* 10 and 11 *Pohlia* 22 and 23. It is due to chromosomal fragmentation. The sexuality in moss populations has been studied by Mehra and Khanna (1951). Externally all these populations look morphologically alike and there are no means to recognise them externally e.g. In *Hyophila involuta* populations, there are 7 and 13 chromosomes. In *Pohlia longicola* their populations with 11, 20 and 22 hromosomes but externally they all look very much alike. There s a v a t field for cytological investigation of Indian mosses as some of their characters like peristome teeth, their whorls and their evolution etc., are correlated with sexuality and chromosome numbers.

SPECIES OF MOSSES IN MAHARASHTRA

(Compiled with the help of Dabhade, 1974, Brotherus, 1924-28, Bruhl 1931, and Blatter 1929)

Classification followed here is that of Dixon (1932) based on Fleischer (1902-1922), Brotherus (1924-1925) and by R. Van der Wijk and Chopra R. S. 1966 in their *M..nographs of the Indian Mosses.* C. S. I. R. Publication.

Serial No.	Name of Species	Habitat
Family 1.	Polytrichaceae ;	
1	*Pogonatum aloides* (Hedw) P. Beauv forma *neesii* (C. Muell) Gong.	Terrestrial on laterite soil

Serial No.	Name of Species	Habitat
Family 2.	Archidiaceae :	
2	*Archidium birmannicum Mitt* Ex. Dix.	Terrestrial on sandy soil
3	*Archidium indicum* C. Muell ..	Terrestrial on rock
Family 3.	Fissidentaceae :	
4	*Fissidens splachnodryoides* Broth.	Terrestrial on laterite soil
5	*Fissidens bryoides Hedw.*	Terrestrial on laterite soil
6	*Fissidens curvatoxiphiaides* Dix et Vard	Terrestrial on laterite soil
7	*Fissidens teniolatus* Dix et P. Verd	Terrestrial on laterite soil
8	*Fissidens minutus* Thwait et Mitt.	Epiphytic
9	*Fissidens sedgwickii* Broth. ..	Aquatic on basaltic rocks stones in streams
10	*Fissidens walkeri* Broth	Terrestrial on laterite soil
Family 4.	Ditrichaceae :	
11	*Garckea phascoides* (Hooki) C.Muell	Terrestrial on laterite soil
Family 5.	Dicranaceae :	
12	*Campylopus gouhghii* (Mitt.) Jaeg.	Epiphytic
13	*Campylopus gracilis* (Mitt.) Jaeg.	Epiphytic
14	*Dicranodontium didictyon* (Mitt.) Jaeg.	Epiphytic
Family 6.	Leucobryaceae :	
15	*Octoblepharum albidum* Hedw.	Epiphytic
Family 7.	Pottiaceae :	
	Subfamily—Trichostomoideae :	
16	*Pleurochaete squarrosa* (Brid.) Lindb	Terrestrial on sandy soil
	Subfamily—Fucladioideae	
17	*Anoectangium stracheyanum* Mitt.	Terrestrial on sandy soil
18	*Hymenostyliumrecurvirostre* (Hedw.) Dix.	Terrestrial on basalt rock
19	*Hyophyls involuta* (Hook.) Jaeg.	Terrestrial on basalt rock
20	*Hydrogonium consanquineum* (Thwait et Mitt.) Hilp.	Terrestrial on sandy soil
21	*Semibarbula orientalis* (Web.) Wijk et Marg.	Terrestrial calcareous soil
Family 8.	Funariaceae :	
22	*Physcomitrium coorgense* Broth ..	Terrestrial on sandy soil
23	*Funaria hygrometrics* Hedw.	Terrestrial on basalt rock
24	*Funaria* (*Entosthodon*) *nutans* (Mitt.) Broth.	Terrestrial on sandy soil
25	*Gymnostomiella varnicosa* (Hook) Fleissh.	Terrestrial on calcareous
26	*Splachnobryum indicum* Hamp. et. C. Muell.	Terrestrial on basalt rock

Serial No.	Name of Species	Habitat
Family 9.	Bryaceae :	
27	*Anomobryum auratum* (Mitt.) Jaeg.	Terrestrial on basalt rock
28	*Pohlia fleuosa* Hook.	Terrestrial on basalt rock
29	*Brachymenium acuminatum* Harv.	Terrestrial on sandy soil
30	*Brachymenium exile* (Doz et Molk.) Bosch. et Lac.	Terrestrial on sandy soil
31	*Bryum ghatense* Broth. ex. Dix.	Terrestrial on basalt rock stone walls.
32	*Brachymenium nepalense* Hook.	Epiphytic or on rock
33	*Brachymenium turgidum* Broth. ex Dix.	Epiphytic on tree bark
34	*Bryum coronatum* Schwaegr	Terrestrial on sandy or Brickwalls.
35	*Bryum argenteum* Hedw.	Terrestrial on basalt rock
36	*Bryum wightii* Mitt.	Terrestrial on sandy soil
Family 10.	*Bartramiaceae* :	
37	*Batramidula bartramioides* (Griff.) Wijk. et Marg.	Terrestrial on sandy soil
38	*Bartramidula roylei* (Hook. f.) B.S.G.	Terrestrial on sandy soil
39	*Philonotis heterophyalla* Mitt.	Terrestrial
40	*Philonotis hastata* (Dub.) Wijk. et Marg.	Terrestrial on basalt rock
41	*Philonotis secunda* (Doz. et Molk.) Bosch. et Lac.	Terrestrial on basalt rock
Family 11.	Erpodiaceae :	
42	*Erpodium mangi Ferae* C. Muell.	Epiphytic on bark of banyan.
Family 12.	Orthotrichaceae :	
43	Macromitrium sulcatum (Hook.) Bird.	Epiphytic on mango bark
Family 13.	Leucodontaceae :	
44	*Leucodon secundus* (Harv.) Mitt.	Terrestrial on sandy soil
Family 14.	Trachypodaceae :	
45	*Diaphanodon procumbens* (C. Muell.) Ren. et Card.	Epiphytic hanging from branches
Family 15.	Pterobryaceae :	
46	*Prerobryopsis walkeri* (Broth.) Borth	Epiphytic on bark of trees
Family 16.	*Meteoriaceae* :	
47	*Meteoriopsis reclinata* (C. Muell) Fleisch.	Epithytic on branches of tress.
Family 17.	Neckeraceae :	
48	*Pinnatella calcutensis* Fleisch.	Epiphytic

Serial No.	Name of Species	Habitat
Family 18.	Thuidiaceae :	
49	*Thuidium cymbifolium* Doz. et Molk.	Terrestrial on sandy soil
Family 19.	Brachytheciaceae :	
50	*Rhynchostegiella humillima* (Mitt.) Broth.	Terrestrial on sandy soil
Family 20.	Symphyodontaceae :	
51	*Symphyodon angustus* (C. Muell) Jaeg.	Epiphytic on tree bark
Family 21.	Entodontaceae :	
52	*Entodon plicatus* C. Muell	Terrestrial on moist ground in ghats.
53	*Entodo prorepens* (Mitt.) Jaeg.	Terrestrial on sandy soil
54	*Levierella fabroniacea* C. Muell	Epiphytic on bark
Family 22.	Plagiotheciaceae :	
55	*Stereophyllum tavoyense* (Hook) Jaeg.	Epiphytic on bark
56	*Stereophyllumanceps* (Bosch.etLec.) Broth.	Epiphytic on bark
57	*Stereophyllum ligulatum* Jaeg.	Epiphytic on bark
Family 23.	Sematophyllaceae :	
58	*Glossadelphus vivicolor* (Broth. et. Dix.) Broth.	Epiphytic on bark
59	*Glossadelphus zollingeri* (C. Muell)	Terrestrial on basalt rocks and on stones
Family 24.	Hypnaceae :	
60	*Bryosedgwickia kirtikarii* Card et Dix.	Epiphytic on trees
61	*Ectropothecium cyperoides* (Hook.) Jaeg.	Epiphytic on tree bark
62	*Vesicularia reticulat a*(Doz.et.Molk) Broth.	Terrestrial on sandy soil

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CHAPTER IV

PTEROPSIDA OR VASCULAR CRYPTOGAMS

CONTENTS

CHAPTER IV—*contd.*

CHAPTER IV

PTEROPSIDA

VASCULAR CRYPTOGAMS

PTERIDOPHYTA

Next to Angiosperms is the group of Vascular or higher Cryptogams. They are a very ancient group known from the Silurian Devonian period to Modern times. Habit and form of many of them have changed through ages. Some of them have even become extinct. Unlike Bryophyta they have vascular elements or vessels in them. They have antheridia and archegonia like Bryophyta; but the structure of archegonium is continued further in Cycads, Ginkgo and Conifers. Hence these groups are sometimes classed as Archegoniatae. They also share another character with higher plants in possessing a concealed embryo, and are, therefore, classed as Embryophyta which includes Bryophyta, Pteridophyta, Gymnosperms and Angiosperms also. It is customary to recognize 4 categories or groups of pteridophytes which are summarized in table No. IV-1.

TABLE No. IV-1

SUMMARY OF MAIN GROUPS OF LIVING VASCULAR CRYPTOGAMS

Class	Order	Family	Distribution in world		Distribution in India		Distribution in Maharashtra	
			Genera	Species	Genera	Species	Genera	Species
I. Psilopsida	Psilotales	Psilotaceae	*Psilotum*	2	Psilotum	2	1	1
			Tmesipteris	2				
II. Articulatae	Equisetales	Equisetaceae	*Equisetum*	45	*Equisetum*	5	1	2+1 variety
III. Lycopsida	Lycopodiales	Lypodiaceae				34	1	2
		(*A*) Homosphorae	*Lycopodium*	180	*Lycopodium*			
			Phylloglossum	1				
		(*B*) Heterosporae						
		Selaginellaceae	*Selaginella*	800	*Selaginella*	64	1	5
		Isoetaceae	*Isoetes*	70	*Isoetes*	6	1	3
			Stylites	2				
IV. Filicopsida	Filicales (Series I)	Filicinae						
		Homosporae :						
		Eusporangiatae :						
		(*a*) Ophiglossaceae	*Ophioglossum*	43				
			Botrychium	34				
			Helminthostachys	1				
		(d) Marattiaceae	7	53	*Angiopteris*	1	1	1
					Marattia	1	7	1
	(Series-II)	(*c*) Osmundaceae	3	19	*Osmunda*	3		
		Leptosporangiatae						
			235	8700				

The number of Homosporous families varies according to the classification followed by different authors.

It is estimated that there are 605 species of Ferns and Fern allies (500+ 105) in India.

Class	Order	Family	World Genera	World Species	India Genera	India Species	Maharashtra Genera	Maharashtra Species
	(Series-III)	Heterosporae :						
		Marsiliaceae	*Marsilia*	53	*Marsilia*	10	1	3
			Pilularia	6				
			Ragnelidium	1				
		Salviniaceae	*Salvinia*	10	*Salvinia*	2		
			Azolla	6	*Azolla*	1	1	1

Remarks on the Table :—

1. Estimates of total number of genera and species differ much according to the system of classification followed for Filicales : Christansen (1938) gives 247 genera and 9,000 species, Copeland (1947) gives 229 genera, Holttum (1949) gives 300 genera and 10,000 species.

2. Osmundaceae is generally treated as a separate order with a single family Osmundaceae and intermediate between Eusphorangiates and Lepto sporangiatae because of marginal tassels,or/and super ficial sporangia on the lower surface of leaf, rudimentary annulus and vertical dehiscence. It has three genera *Osmunda* having 12 species, *Todea*, 1, and *Leptopteris* 6. In India *O. regalis; O. cinnemomea* and *O. claytonia* are found; but in Maharashtra only *O. regalis* occurs. *O. cinnamomea* grows in N E F A and D. *javanica* is often cultivated in garden.

3. Leptosporangiatae are variously classified into different families and sub-families, but generally 13-15 families are recognized. Of these family polypodiaceae is the largest family comprising 170 genera and about 7,000 species.

Peranema sp. *cyathcoides* (fam. Dicksoniaceae) like *Diacalpe* is monotypic.

4. Tree ferns do not occur in Maharashtra but occur in neighbouring region of Goa and North Kanara.

5. There are 15-17 families of Leptosporangiate ferns in Maharashtra and about 60 species.

6. It is estimated that India has more than 600 species (about 705) of pteridophytes. Of these 105 are fern allies and the rest ferns. Gray (1886) has described 50 species as occurring in Bombay Presidency, and Blatter and d' Almeida (1922) have described 57. The group is badly in need of thorough revision in the light of several modern works.

1. ORDER : PSILOTALES

Family Psilotaceae

This Family of Vascular Cryptogams is represented in the world by only two living genera. In the past they had many representatives, but at present they are survived by 2 genera and 4 species. The first genus *Psilotum* is more or less cosmopolitan in Tropics, and the second genus *Tmesipteris* is endemic in Australia and New Zealand. There are only two species of *Psilotum, P. nudum* (L) *Beauy.* (=*P. triquetum* SW.) and *P. complanatum* SW. They occur in India. *Tmesipteris* has 2 species, *Tmesipteris tannensis* Bernh., and *Tmesipteris vieillardi* Dangeard. They do not occur anywhere in India.

Psilotum nudum grows terrestrially in the crevices of rocks or in walls of wells. It also grows epithetically on *Ficus retusa* or in the midst of roots of *Phoenix sylvestris* or *Euphorbia* sp. . But on the whole is very rare plant. It used to occur in a well at Ghodbandar near Bombay. It grows mixed up with the clumps of *Euphorbia tridentata*. But due to repeated collections by unscrupulous collectors and by students out of curiosity, the plant has nearly disappeared. It was once collected by

Mahabale and Deshpande (1942) at Lonavala (District Pune) growing epiphytically on a tree of *Fucus retusa* on old branches. Presumably it may be found in other places also in high rainfall areas at higher altitude. It is fairly common at Pachmadhi (MP),Castle rock and Dandeli (Karnatak State).

Bierhorst (1971, 1973) regards *Psilotum* and *Tmesipteris* as ferns.

2. ORDER : LYCOPODIALES

Family Lycopodiaceae

Lycopodiales like Filicales are a very ancient group and are represented by 2 living genera. In fossils they have several forms, known from Devonian to Jurassic period. In Carboniferous period fossil members had tree habit which they do not possess any longer. In India about 30 species of *Lycopodium* are known of which two occur in Maharashtra and a third one in Mysore Forests.

Lycopodium cernum Linn. is a terrestrial species and occurs in places around Castle Rock, now in North Canara district and in Goa near Collem. The other species is *Lycopodium hamiltoni* Spring. The third species *L. phlegmaria* Linn grows very sparingly in thick forests in Mysore and Ooty. *L. hamiltoni* is epiphytic and is not uncommon at Mahabaleshwar on tall trees in Fitzgerald Ghat, and in the Raiwood near Railway station at Lonavla. It is a small species, 10-15 cms long, having large axillary sporangia towards growing apex as *those* in *L. selago*. It has no cones. Reproductive and vegetative zones alternate.

On the other hand, sporangia of *L. cernum* and *L. phlegmaria* occur in terminal portions of branches as spikes and are often dichotomised. They are erect in *L. cernum* and pendulous in *L. phlegmaria* Sporangia of *L. cernum* form terminal cones or spikes at the end of vertical branches, but those of *L. phlegmaria* droop down. The genus obviously is dwindling. Birdwood (1887) in his *Catalogue of Matheran and Mahabaleshwar Plants* has recorded 2 other species of *Lycopodium*. *L. imbricata* Spring and *L. obtusatum* Fairbank, but they have not been found by subsequent authors. Presumably *Selaginella* was mistaken for them.

3. ORDER : EQUISETALES

Family Equisetaceae

Equisetales also are a very ancient group having had many tree-like representatives in the Palaeozoic, especially in the carboniferous period. But its tree-like representatives completely disappeared with the onset of Mesozoic era. In India it has 5 fossil representatives namely *Schizoneura gondwanensis* Feist; *Phyllotheca* having 2 species *P. indica* Burmi; *P. Sahnii*, *Saksena*, *Stellotheca* 1 species. *S. robusta* Feist., *Raniganjia* 2 species, R. *bengalensis* (Feist.) Rigby, *R. indica* (Strivastava) Rigby · and *Neocalamites* 1 species of a tall bamboo like genus peculiar to southern continents during the Triassic period. Ultimately they all died and were survived by a small reed like plant called *Equisetites*. It is the nearest relative of the only surviving genus of the family, Equisetum.

Genus—*Equisetum*

There are thirty-two species of this genus in the world of which 4-5 occur in India. *E. debile* Roxb. *E. ramasissimum* Desv., *E. arvense* Linn., *E. diffusum* Don Prod., A fifth species *E. palustre* L. is recently reported from Kashmir. Only two of these species occur in Maharashtra. *E. debile* Roxb. is a small plant with irregular branches and short internodes, apiculate terminal cones, subtended by a few lower branches, also bearing small terminal cones below the larger cone on the main branch. It has two distinct varieties one is known as *E. debile* Roxb. proper and the other *E. debile* var. *Pashani* Bhide named after Pashan village near Pune where it grows wild and was found first by R. K. Bhide, the famous Herbarium Keeper at the Poona Agricultural College, and a well-known worker on grasses of Bombay. Since the diagnosis of this was not given it is given below :—

Equisetum debile Rox. var. *pashani* Bhide. Plants generally 15-20 cm. long when it grows near tree, it could be more in length. Stem is 3 mm thick in diameter with 7-14 ridges and furrows. The nodal teeth or scales are small brown or purple, adherent to node. They are not very prominent. Branching is irregular. Some of these branches have small terminal, appiculate cones below the large terminal cone on main stem. Annulus not prominent. Apiculate cones have 30-40 sporangiophores, each having 10-12 sporangia below each peltate hexagonal plate, two at each corner.

Locality : Pashan (Near Pune). This variety is pretty common a Pashan tank near Pune after which it is named. It grows also a Tumuri near Belgaum. *E. debile* proper is a larger plant 30-40 cm tall, it is common in Punjab on the banks of Ravi river at Lahore, N. W. Himalayas, and regions beyond Afghanistan. *Equisetum debile* grows on the banks of Godavari river at Kopargaon (Ahmednagar), at Nanded in Marathwada, and at several other places. It grows in Nagpur in the Nag river and forms a bed in Bhima river at Daund, Padegaon, Pandharpur etc.

The second species *E. ramosissimum* Dave is very widely spread in Madhya Pradesh, Uttar Pradesh, in extra-peninsular India, and in trans-Indus region. It has a large number of varieties all over Europe and Middle East.

4. ORDER : SELAGINELLALES

Family : *Selaginellaceae*

Genus : *Selaginella*

Selaginella is a heterosporous member of the Selaginales. It has about 800 species in the world. Alston (1945) has reported 58 species of *Selaginella* in India, a few more species have been added recently. In Maharashtra the genus is common in Konkan and at all hill stations. It is rare in plains. Five species of it have been reported from Maharashtra.

1. *S. cilliaris* (Retz.) Spring.—This is a very small species hardly 2—6 mm growing generally mixed up with grasses.

2. *S. miniatospora* Baker.—This species 3-5 cm long creeping or erect, restricted to high elevations with high rainfall. Spores are reddish in colour and because of this character it can be easily picked up in field.

3. *S. proni flora* (Lamk.) Baker (=*S. dalzellii* Baker, 1885).

This is common in Mahabaleshwar, Ghats, Devimani Ghat and in Malabar. *S. reticulata* Spring is a small form of *S. proni flora*. It is a creeping, very delicate species. It has pale green leaves 3-10 mm long on the lower surface. Leaves below the tip of branches are often equal sided, and cordate. It is strongly ciliated. Spikes are terminal, apiculate 1-2 cm long. It grows near wet rocks with tricking water.

4. *S. tenera* (Hook and Grev.) Spring.—This species is common in Konkan, North Canara from Sirsi to Siddapur. It is 12-30 cm long erect, leaves are bright green, suberose. Leaves on the lower plane ascending, contiguous. Those on the side branches, bright green, oblong rhomboida. Those on the upper surface very-small, lanceolate cuspidate spikes are very small 1/10th of a cm in length. The species is very common in Peninsular India and Sri Lanka. It grows abundantly at Ratnagiri.

5. *S. delicatula* (Desv.) Alston — *S. flaccideum* Bory.—This species is common in Konkan, Sawantwadi, Bombay, Lonavla, Pune and Salsette Island etc. It is also found in Coorg, at Yellapore (District North Kanara) Andamans, Nicobars etc. It is a suberect species with copious pinnate branches, profusely compressed. Leaves on the lower plane ascending, oblong, acute, very small, less than 1/10 of a cm. membraneous equal-sided, narrow at the base. Leaves on the upper side still smaller oblong, cuspidate. Spikes copious, slender, 1-3 cm long about 0.5 cm in diameter. It often grows near water courses. Its stem is transparent, pale white and fleshy. It grows during rainy season and no trace of it can be had afterwards. It is found by the side of rocky hill streams at Lonavla.

According to Baker (1897) the genus consists of four sub-genera which comprise several series and groups. In the first subgenus (1) *Selaginella* proper all ordinary leaves are alike, multifarious; the bracts are uniform. There are 8 species in this subgenus. (2) In the second subgenus *Stachygynandrum* ordinary leaves are of two kinds, spreading in two planes. Those in the upper plane being more ascending and smaller. This sub-genus has the largest number of species, namely, 250. (3) In the third sub-genus, *Homosathyse* there are two kinds of vegetative leaves spreading in two planes. The bracts also are dimorphous, smaller bracts being in the same plane as the smaller leaves which are more ascending. Only two species were included under this sub-genus by Baker but now only *S. pallidissima* Spring is retained under this subgenus as *S. ciliaris* (Retz.) Spring is now generally considered to be the same as *S. prolifera* Baker; (4) In the fourth sub-genus, *Heterostachys* there are two kinds of leaves spreading in two different planes. The bracts are resupinate, i.e., smaller bracts in the same plane as that of larger leaves and larger bracts in the same plane as that of the smaller leaves. This subgenus comprises 64 species.

All these subgenera are represented in Indian flora but not all in the flora of Maharashtra. According to Baker (1887) 53 species occur in India of which *S. flaccida* Spring and *S. semicordata* Spring and *S. radicans* Spring and are the same as *S. proniflora* Baker. It has dwarf variety *S. reticulata* Spring. *S. miniatospora* Baker, *S. dalzellii* Baker *S. proniflora* Baker and *S. tenera* occur in the Bombay Presidency. Alston (1945), however, in his recent enumeration of the species has given 58 species in addition to a few of doubtful identity.

Species of Selaginella in Maharashtra.

1.	Subgenus *Salaginella proper*	.. Nil.
2.	Subgenus Stachygynandrum	..=*S. delicatula.*
		=*S. flaccida.*
		=*S. radicans.*
3.	Subgenus Homostachys ..	..=*S. ciliaris.*
4.	Subgenus Heterostachys ..	..=*S. proniflora.*
		=*S. miniatospora.*
		=*S. dalzelli.*
		=*S. itenera.*

S. reticulata is a dwarf form of *S. prolifera* of Baker. But according to Alston (1945) *S. ciliaris* Spring and *S. prolifera* Baker are the same.

ORDER : ISOETES

Family Isoetaceae

This Order has only two genera : Cosmopolitan genus *Isoetes* and the genus *Stylites* recently discovered by Amstutz in 1957 in Peru (South America). It has two species, *Stylites gemmifera* Raech and *Stylites andicola* Amstutz. They seem to be endemic. Unlike *Isoetes* it has long elongated rhizome. It is not known from any other parts of world and is a link between fossil heterosporous Lycopodiales and living *Isoetes*. Its sporangia are just like those of *Isoetes*. They both being heterosporus.

Isoetes :

It is the second heterosporous member of the Lycopodiales. It is represented by about 70 species in the world according Pfeiffer (1922). Only one species of *Isoetes* was known as occurring in India viz. *I. coromandelina L. Isoetes coromandelina* L. It is the oldest known species of the genus from India since the days of Linnaeus. It grows at Panhala (Kolhapur), Lonavla in (Pune) and other places in Sahyadris in Maharashtra.

In 1938 Mahabale found a second species. *I. sahyadri* Maha. growing mixed with a third species *I. dixitii* named by Professor D. V. Shende (1945) at Pachgani, Satara district. Both these species are not widely distributed and often grow isolated in mountain lakes. *I. Sahyadri* has complete velum. *I. dixitii.* has no complete velum as in *I. sahyadri.* But it has micro, mega and mixed sporangia having microspores, megaspores and sterile cells.

ORDER : FILICALES

The last order of the living Vascular Cryptogams is Filicales. The Filicales also are an ancient group since the Middle and Upper Devonian period. The plants are highly ornamental and are cultivated in the gardens for the exquisite shapes of their foliage. They are shade and moisture loving plants and grow in forest areas on trees, in marshes,

on moist soils, in crevices of rocks, in ravines and Ghats. They are found at all hill stations. Generally they are confined to high altitude but some are also found in the plains by river side, and even at the sea level in marshes and estuaries. About 305 genera and above 10,000 species of them are known, of which about 200-225 species occur in India. Mostly they are confined to Eastern Himalayas, Sahyadries, Ooty, Eastern and Western Ghats. In Maharashtra about 115 species of ferns spread over 55 genera and 10-15 families, are known.

CLASSIFICATION OF FILICALES

The Ferns or the Filicales are generally classified into two series. Christensen's classification given by Verdoorn (1938) in *Manual of Pteridology* with some modifications made by Holttum (1949) and others is followed here

Series I	.. ..	Eusporangiatae
Series II	.. ..	Leptosporangiatae

SERIES I. EUSPORANGIATAE

A.	Ophioglossales	Family	..	Ophioglossaceae
B.	Marattiales	Family	..	Marattiaceae.

The family Ophioglossaceae consists of three genera *Ophioglossum*, *Botrychium* and *Helminthostachys* which are small fleshy ferns.

The genus *Ophioglossum* has about 40 species in the world and 10 in India. The only representative of this family in Maharashtra is the genus *Ophioglossum* having 9 species as listed below. The tenth Indian species *O. pendulam* L-is a large epiphyte found in Assam and Meghalaya, but nowhere else in India. It also occurs in Sri Lanka.

1. *O. gramineum* willd.
2. *O. nudicaule L.*
3. *O- fibrosum* Schum.
4. O. *pedunculosum Prantl* (*sensu non-Desv.*)
5. *O. aitchisonii* d' Alm.
6. *O. reticulatum* L.
7. *O. vulgatum* L.
8. *O. lusitanicum* L.
9. *O. japonicum* Prantl.
10. *O. pendulum* L.

The first 9 species occur in Maharashtra. *O. reticulatum* L. is the largest, having large cordate conspicuously reticulate leaves with a large, more than 5 cm long spike. The leaves are sometimes 2-3 cm broad, 4 cm long with acute apex, 5-12 cm long, over tapped by a big2-5 cm apiculate spike. It grows below trees or in midst of grasses. *O. aitchinsonii* A'Alm, is a hardy, large species with spike arising not at the junction of lamina of leaf and peduncle but the spike arises half way from above the leaf lamina. It is a species of dry gravelly areas growing in the midst of grasses e.g. at Shirur (District Pune). *O. fibrosum* Schum,

is also a large species having a distinct rhizome similar to shape to that of *Amorphophallus* and fibrous roots around. It grows in well drained rocky areas with plenty of water. *O. vulgatum* L. is very rare and doubtfully occurs in Maharashtra. *O. japonicum* Prantl has ovate elliptical 4.5 cm long, 0.5-0.75 cm broad leaves. It is found on the river banks in alluvial soil. *O. lusitanicum* L. is very rare and doubtfully occurs in Maharashtra. *O. nudicaule* L. and *O. gramineum* Willd. and *O. pendunculosum* grow in the midst of grasses either on lawns or on the gravel soils. *O. gramineum* has grass-like leaves 1-3 cm long and 9.2-0.4 cm broad. *O. nudicaule* has 2 forms one with 1 cm broad ovate, apiculate leaves and another with ovate oblong, slightly smaller leaves. Both occur in the midst of grasses and are highly inconspicuous. Both are very small, hardly 2 cm in height.The peduncle is 2.3 cm, much longer than that in *O. gramineum*, placed on a small ovate leaf 0.5 cm wide. *O. pedunculosum* Prantl is a polyphyllous species larger than *O. nudicaule* L., about 3 cm in height, having ovate lanceolate leaves 1-1.5 cm broad. All these species are ephemeral and generally grow in monsoons; afterwards they aestivate in soil. All of them except *O. fibrosum* Schum. Propagate vegetatively by underground suckers producing root buds. Sexual reproduction is very rare as the conditions for the formation of prothalli are exceedingly rare and finding prothalli is considered lucky. They are pale yellow, subterranean, mycorhizic and tuberous. They bear more than 100 reproductive organs and are perennial (Mahabale 1939).

The second genus *Botrychium* has 5-6 species in India, but they do not occur in Maharashtra.

The third genus of the family Ophioglossaceae is *Helminthostachys*. It is a marshy fern. It has rarely been found in this State. It is reported from South Konkan area in marshes of Sawantwadi

The second family of the Eusparangiateae is the Marattiaceae. It comprises genera :

1. *Angiopteris* Hoffm.
2. *Marattia* Sm.
3. *Kaulfussia* Blum.
4. *Archangiopteris* and
5. *Danea* Sm.

Of these *Marattia* and *Angiopteris* occur slightly to the south of Maharashtra at Castle Rock and also in South Konkan,Pachmadhi in M.P. Only *Angiopteris* occurs in Maharashtra, but no locality is known.

SERIES II. LEPTOSPORANGIATAE

The next group or series of Filicales is the Leptosporangiatae. It constitutes the major assemblage of ferns or the Filicales and comprises the following families :

1. Osmundaceae.
2. Schizaeaceae.
3. Marsileaceae.
4. Gleicheniaceae.

5. Matoniaceae.
6. Hymenophyllaceae.
7. Cyatheaceae
8. Polypodiaceae with its 13 sub- families.
9. Dicksoniaceae.
10. Parkeriaceae.
11. Plagiogyriaceae.
12. Loxomaceae.
13. Hymenophyllopsidaceae.

Previously it was customary to divide the Filicales into three groups L. Eusporangiatae, Leptosperangiatae and Hydropteridineae. But the Hydropteridineac is a biological group of water ferns, the families Marsiliaceae and Salviniaceae. The Marsiliaceae is supposed to be related to Schizaeaceae and the Salviniaceae to Hymenophyllaceae Cyatheaceae are large tree ferns, *Azolla pinnata* and *Gymnogramme leptophylla* are the tiniest ferns of all.

1. Family—*Osmundaceae* :

One of the most important ancient family of Filicales is the Osmundaceae. It has about 6-8 species, in the world, by far the commonest of them is cosmopolitan species *Osmonda regalis* L., occurring throughout Peninsular India and elsewhere. It occurs at Mahabaleshwar along some water courses, but it does not grow at other hill stations such as Matheran, Chikhalda etc. *O. cinnamomea occurs in* NEFA and *O. cilaytonia* in Kashmir.

2. Family— *Schizeaceae* :

This family is represented by two wild species of *Lygodium L. flexuosum* Beed. and *L. microphyllum* For. A third species *L. japonicum* Sw. is cultivated. Second genus is Ancimia is commonly cultivated in gardens, especially, the species *A. rotundifolia* and A. *adiantifolia.*

3. Family—*Marsiliaceae*

This is a family of heterosporous ferns. It is supposed to be related to Schizeceae (Bowcr 1932). It has 3 genera : *Marsilea* which is a cosmopolitan genus with 30 species in the world, *Pilularia* with 6 species in temperate countries, and *Regnellidium* a monotypic genus endemic to Brazil, Cuba and Argentina. *R. diphyllum* is the only species of it. *Marsilea* occurs in India, 9 species have been described by Gupta (1962), of which *M. aegyptica* growing in the deserts of Rajasthan in the bed of Luni River near Jodhpur is very unique inasmuch as, its capsule is compressed in the middle dividing the sporocarp into two parts. The tenth species of India is described by Kolhatkar (1957) under the name *M. poonensis* Kolhatkar from Pune.

All these genera possess a bean-like or round spore capsule arising from the node or from the base of the petiole, or above the stalk of the petiole. In *Marsilea quadrifolia* the sporocarp is stalked and 3-4 of them arise one above the other on the base of petiole. In *Pilularia* the sporocarp is short stalked one on each, small and round. In *Regnellidium* it is

globular one on each stalk packed with mega—and microspores in verticle compartments. It has two leaves. The structure of sporocarp and mode of germination in each genus are different (Mahabale, 1956).

The plant produces a number of floating leaves on the surface in water, and suckers when trailing on marshy ground. *M. quadrifolia* is the largest in size, petioles long -8-12" and has four teaflets on a petiole; *M. erosa* or *M. minuta* is a small species with 3-4" long petioles. It also produces several stalked sporocarps distinct from the base of petiole at each node. In *M. poonensis* there are 2-3 sporocarps arising separately on stalks from below petiole.

Regnellidium diphyllum is exotic and is now cultivated in Botanical gardens in universities like Lucknow, Pune, Delhi, Dacca etc. Its sporocarp is also stalked, but generally only one arises on each stalk, close to the base of the petiole. It also bears both mega and microspores in compartments in the same sporocarp. A fossil species of a water fern genus related to *Regnellidium* was found by Dr. Sahni and has been named after Professor K. P. Rode as *Rodeites*. It is found in the Intertrappean beds of Chhindwada area of Tertiary period.

In Maharashtra *M. quadrifolia* is common in ponds, lakes and riversides. *M. erosa* is found in shallow drying ponds in South Gujarat, Thane and Baroda.

M. poonensis is reported from Pune and vicinity and grows abundantly by the Mutha river. A species named *M. konkanensis* has been reported by early authors but has not been reported again by anybody so far.

All these species propagate vegetatively as well as by sexual reproduction from spores.

4. *Gleicheniaceae* :

There are 6 genera in this family, but none occur in Maharashtra. *G. linearies* Bedd. occurs in North Kanara adjacent to Maharashtra and Goa. It is a terrestrial fern with repeatedly dichotomised creeping stem and a dormant bud in the axil of each dichotomy. It has naked groups of sporangia.

5. Family—*Matoniaceae* :

Matoniaceae are tree ferns mostly from Malaya. They do not occur in Maharashtra but they are found in Sri Lanka (Ceylon), Malaya, Assam etc.

6. Family—*Hymenophyllaceae* :

The Hymenophyllaceae are filmy ferns belonging to 10 genera. They are represented by 2 genera-*Hymenophyllum* and *Trichomanes*. Both are common at Castle Rock but not in Maharashtra except in Sawantwadi region.

7. Family—*Cyatheaceae* :

These are tree ferns. The family has two genera, *Cyathea* and *Alsophila* which modern authors merge into one genus *Cyathea*. Both grow in North Kanara forests, Pachmadhi etc., but none in Maharashtra.

8. Family—*Dicksoniaceae* :

Dicksoniaceae are tree ferns with moderate height. Out of 6 genera of it, only one member *Peranema cyatheoides* Don. having 1.2-1.5 cm delicate fronds occurs at Mahabaleshwar in shady places. It has a round sorus raised on a thread like stalk. The family is monotypic and rare.

9. Family—*Polypodiaceae* :

The family is very large with 13 sub-families. Of these Dennstatioideae and Demnstaedtieae are tree ferns. Plagiogyriaceae do not occur in Maharashtra. The rest have a few members each. Further classification of this family is extremely varied according to views of different authors such as Bower (1926, 1928), Christensen (1938), Ching (1940), Copeland (1947), Holtum (1947) Pichi—Sermoli (1959). The following taxa constituting 13 sub-families are given here. The classification generally followed here is the one followed by Blatter and d'Almeida (1922) and Bower (1926, 1928) with some modifications. We have not included, in the list below, such sub-families as have no representatives in Maharashtra.

Family—*Polypodiaceae* :

Sub-family (1) Lindsayoideae
(2) Davalliodeae
(3) Oleandroideae
(4) Pteridoideae
(5) Adianteae
(6) Cheilanlantheae
(7) Blechnoideae
(8) Aspleniodeae
(9) Theylpteroideae
(10) Polypodieae
(11) Acrostichoideae
(12) Gymnogrammeae
(13) Drypteroideae

Family—*Parkariaceae.*

Family—*Plagiogyraceae.*

1. Sub-Family-*Lindsayoideae* :

It has only one genus *Schizoloma* wild and another cultivated *Lindsaya. Lindsaya cultrata* Sw. is grown often in gardens. The genus *Schizoloma* has sori lying on deeply curved lobes.

2. Sub-Family—*Davallioideae* :

All members of this sub-family have half cup-shaped sori. A species *Davallia bullata* Wall is reported from the Western Ghats. *D. fijiensis* H. K. is grown in gardens being highly ornamental. Another member

of this family is an epithytic creeper, *Leucostegia. L. pulcra* J. Sm. grows on mango trees at Lonavla and at Mahabaleshwar. Second species *L. imersa* Presl., grows in the crevices of rocks, or epithylically, in the Ghat section at Mahabaleshwar and Lonavla. The third genus of the family is *Microlepia* Presl. Species *M. speluncae* Bedd; is wild and grows at Panhala near Kolhapur and at Pachgani.

3. Sub-Family—*Oleandroideae* :

A single row of large round sori lying parallel to midrib distinguishes the members of this sub-family. Only one species of the genus *Oleandra* Kunz. Occurs viz. *O. musawefolia* Kunz. It is wild at Pachgani.

4. Sub-Family—*Pteridoideae* :

The sub-family Pteridoideae is a large one, often variously resolved and dissolved from time to time. The marginal sori are linear, fused to make coenosorus. The genus *Pteris* L. is a large one having about 280 species of which 8 occur in the State. *P. longifolia* L. now called *P. vittata*, is wild in many places in dry hills. It is also cultivated in the gardens. *P. cretica* and *Pteris var. albolineata* (a horticultural variety), *P. ensyormis* Burm., *P. pellucida* Presl are common at Mahabaleshwar Salsette Island, Matheran, Melghat etc., *P. quadriourida* Retz. and *P. biaurita* have several forms. They are very common ferns at Pachgani, Amboli, Khandala, Vetora in Sawantwadi. *P. eritica, P. patens* and *P. wallichiana* Ag. are sometimes grown in gardens. *P. aquilina* L. is both wild and cultivated. It is a weed on cleared waste lands in forests at Mahabaleshwar and other places. *Actinopteris dichotoma* is a common small palm like fern of dry hills and walls of forts and old fortifications at many places.

5. Sub-Family—*Adianteae* :

Previously this sub-family was included under Pterideae, but Holttum (1949) proposed a separate family for it on account of its marginal sori distinctly confluent or separate lying under curled leaf lobes. The genus *Adiantum* has 6-7 wild species and an equal number of cultivated ones. It is a large genus growing pretty wild in wet crevices of rocks. It is often cultivated in gardens for its handsome foliage. About 15 wild and cultivated species of it occur in Maharashtra State. Of these *A. lunulatum* Burm., *A. caudatum* L. *A. tenerum* SW., *A. capillus* veneris L., grow wild and *A. peruvianum* Klotzeh., *A. trapeziforme* L., *A. formosum* R. Br., *A. microphyllum* SW., *A. aethiopicum* L., *A. cuneatum* Lang. and Fisch. *A. gracillimum* Moore, *A. concinnum* H. B. *A. collisii* Moore, *A. hispidulum* SW., are the cultivated ones; *A. caudatum* and *A. lunulatum* are 'Walking ferns'.

6. Sub-Family—*Cheilantheae* :

The members of this family have triangular lanceolate bipinnatifid fronds with white rufous or white powder on the lower side of leaf. The margin of pinnules is curved.

The genus *Cheilanthes* Sw. has three wild species in Maharashtra. *C. farinosa* Kaulf. grows in open places in forests, on cutting of hills at Mahabaleshwar, Lonavla, Toranmal and other places. *C. crysophila* is called a 'Golden fern'. Sometimes it is considered only as a variety of *C. farinose* Kaulf. It has golden yellow rufous or powder on the lower surface of the leaf and hence the name 'Golden fern'. *C. albomarginata* Clarke has white veins. It is also common at hill stations such as Igatpuri,

Khandala, Matheran, Amboli. It is also referred to as 'Silver fern, *C. tenuifolia* Sw. is a very small species. It is found at Ravali hill in Bombay Island, but it is more common in the Ghats of Madhya Pradesh in Vindhyas.

7. Sub-Family—*Blechnoideae* :

It is characterised by sporophylls with coenosori, adherent to the midrib on both sides throughout the length of pinnule. The plants look like small tree ferns. Genus *Blechnum* L. is represented by *B. orientale* L. *B. occidentale* L. A third species *B. volubilis* Sw. is sometimes cultivated in gardens.

8. Sub-Family—*Asplenioideae* :

The taxon Asplenioideae is very large and heterogeneous. It is now split up into many genera other than *Asplenium*. Its fused sori occur below and above the secondary veins and form linear coenosori. The genus *Thamnopteris* Presl. has very large fronds. *Asplenium* has four wild and three cultivated species. The genus *Athyrium* Roth. has three wild species. *A. gymnogrammoides* Bedd. and *A. hookerianum* Bedd. are common in hills in rainy season. Another genus *Diplaz ium* Swartz has three wild species. It is closely related to the genus *Anisogonium* Presl. *A. esculentum* Presl. is the only species of it in Maharashtra. It grows wild along the sandy river banks. It is an edible fern. A few sori occur in it on both the sides of tertiary veins. In the genus *Athyrium* they occur around the tips of veinlets of dichotomised veins.

9. Sub-Family—*Thelypterideae* :

In this sub-family indusium being absent the sori are naked, more or less round or kidney-shaped, rarely elliptical attached by a central stalk and lodged in small cavities. Fronds are bipinnatifid. The common genera are *Thelypteris, Cyclosorus,* and *Goniopteris* Presl. *Pleochnemia* Presl, *Lestrea* Presl, *Nephrodium* Schott and *Nephrolepis* schott. Of these *Pleochnemia, Nephrodium*. *Gymnopteris* and *Lastrea* occur wild.

The genus *Gymnopteris* Presl is a semi aquatic fern and is also cultivated. Its two wild species are *G. presliana* Bedd and *G. contaminans* Bedd. They grow in rocky situations. The genus *Pleocnemia* Presl has three species two cultivated and one wild *P. membranacea* Bedd. It grows in monsoon on trees at high altitude. The genus *lastrea* Hooker, has short stalked, peltate, round sori. It grows on moist rocks and by the sides of hill streams and rivers. In the gardens, however it grows much better and is represented by five or more cultivated species. *Nephrodium* is a large genus with kidney-shaped, peltate sori. It is represented by nine species. *N. molle* (—*Thelypteris molle* desv) is very common throughout India. The related genus *Nephrolepis* has many cultivated forms and varieties. Six species of it are wild. *N. exaltata* Schott. is the most common species. *N. cordifolia* Baker and *N. paucirondosa* d'Alm are small plants in caves at Pachgani; cultivated *N. cordifolia* var *Duffi* is a very large fern with 15.30 cm or more long fronds. It has run wild on the Malabar hill slopes at Bombay.

10. Sub-Family—*Polypodiaceae* :

The family includes genera like *Goniopteris, Phegopteris* etc. *P. armata* Bedd., has very large broad fronds sometimes extending upto 20-25 cm. *Goniopteris prolifera* Presl. grows profusely near water courses.

but seldom produces sori. The species of *Niphobolus* Kauf. and *N. adanscens* Kauf. is a small fern found growing on trees. The genus *Pleopeltis* H. and B. has large round sori. Its species are often cultivated or may be wild terrestrial or epiphytic, *P. linearis* Bedd., and *P. membranacea* Bedd. are common epiphytes on tree trunks and branches in rainy season. Both these species aestivate after rains. Several plants grow on higher branches. *Pleopeltis irioides* and *Pleopeltis phymatodes* are cultivated large ferns.

Drynaria quercifolia is an epiphyte on trees in humid forests in ghats and by the side of sea coast in Ratnagiri and Sawantwadi. It has large naked sori and two kinds of leaves, some humus collecting and some photosynthetic. The former are small and fanshaped. It is common in forests at Ratnagiri, Mahabaleshwar etc., where it sometimes covers all the branches of trees.

11. Sub-Family—*Acrostichoideae* :

The Sub-Family Acrostichoideae consists of genera *Stenoloma* J. Sm., *Egenolfia*, *Gymnopteris* Presl, and *Acrostichum* L. *Stenoloma palustre* Bedd., grows as a climber in forests on tall trees. It climbs almost to the top of trees in Sawantwadi forests and Goa. The genus *Gymnopteris* is a semi-aquatic fern and is often cultivated. The genus *Acrostichum* L., species *A. aureum* L. is a marine mangrove fern. Its fertile leaves are fully studded with golden yellow sporangia on the lower surface. They show what is known as " Acrostichoid distribution of sori " all over the backside of leaf. It grows in tidal backwaters and estuaries as a mangrove in Goa and adjacent places. *Egenolfia appendiculata* grows in hills at Bhimashankar, Mahabaleshwar etc.

12. Sub-Family—*Gymnogrammeae* :

The genus *Gymnogramme* Desv. has two handsome species. One *G. leptophylla* Desv. grows in the chinks of walls of bungalows at hill stations. It is one of the smallest ferns known. Second *G. calomelanos* Kaulf. has white powder on the backside of leaves. A variety of it called *G. chrysophylla* has golden powder on the lower surface of leaves. The silver leaved species *G. calomelanos* is abundant on Andheri hills (Bombay), Mahabaleshwar etc.

13. Sub-Family—*Dryopteroideae* :

The family consists of genera *Pleopeltis* Don., *Dryopteris* J. Smith., *Polystichum* Roth., *Cyrtomium* Presl. The genus *Pleopltis* Don., has three species, two cultivated and one wild epiphytic, *P. membranacea* Bedd. The genus *Cyrtomium* has one species *C. falcatum* Presl. It is a thick leaved fern with scattered naked sori. It grows wild and is also cultivated in the gardens.

Family—*Parkeriaceae* (*Ceratopterideae*) :

This is a monogeneric family represented by the single genus *Ceratopteris* Brong., also called *Parkeria*. It is separated from Polypodiaceae on account of its dimorphic fronds, acrostichoid distribution of sori, with or without indusium, and spores with highly characteristic ridges on them. Two or three species of it are recognised in the world, but in India and Maharashtra *C. thalictroides* Brong. only grows. It is common in ponds and marshy places at Khandala, Bombay, Khindsi, etc.

Family—*Plagiogyriaceae*

Loxomaiceae, Hymenophyllohylaceae do not occur in Maharashtra. Though *Hymenophyllum* and *Trichomanes* are said to occur in south Ratnagiri forests on tree trunks.

Family—*Salviniaceae* :

This is the second family of water ferns allied to Hymenophyllaceae. It is very small family and consists of two genera *Salvinia* and *Azolla*. Salvinia does not occur in Maharashtra but is cultivated in tanks. *Azolla* occurs in tanks, lakes and monsoon ponds. *Azolla pinnata* is the only species growing in temple ponds, small lakes below Sahyadri ranges. It is found in a temple pond at Ganapatichi Pali in Raigad district, etc. It is pretty common in ponds in Londa and Tinaighat forests in Karnatak. *Salvinia* has about 10 species and *Azolla* 6. A fossil species of *Azolla* is found in the Deccan Intertrappean beds at Sausar near Nagpur, but is different from *Azolla pinnata*. *Salvinia cuculata* is cultivated in water reservoirs and also *Salvinia auriculata*. Both are exotic. *Salvinia intertrappea* Mahabale is a fossil species found at Mohgaon Kalan, Paradshinga near Nagpur. It is related to *Salvinia auriculata* of Brazil.

CONCLUSION

On the whole, Maharashtra is quite rich in pteridophytes. There are about 55-60 ferns and 11 non-fern pteridophytes known, so far. Many areas in Chandrapur, Chikhaldara, Melghat, Nagpur, etc., have not been explored, and a fresh search will be rewarding. These areas have also not been explored for Bryophytes (mosses and liverworts).

The names of some ferns in India have been changed. For these recent name changes B. K. Nair and Kaur (1974) be consulted.

Most of the fern families listed above have fossil representatives also which are not considered.

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CHAPTER V—GYMNOSPERMS

CONTENTS

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Gymnosperms constitute a very large assemblage of woody trees; a few are shrubs. They occur in plains as well as in mountains up to tree and snow line. They are of great antiquity. As a matter of fact, more fossil Gymnosperms are known than living ones. Some have living as well as fossil representatives; some are exclusively extinct.

1. Living Gymnosperms

The living members of gymnosperms belong to four different orders.

Orders	Families	Genera	World species	Species in India	Indigenous species in Maharashtra
Cycadales	1	9	100	6	0
Ginkgoales	1	1	1	0	0
Coniferales	7	48	520	40	0
Gnetales	3	3	70	5	1

2. Fossil Gymnosperms

The fossil members are classified as below, many of them being extinct—

2·1. *Pteridospermeae or Seed-ferns* (*Cycado-filicales*).—These are a group of small trees of medium height. They have fern-like foliage, foliar sporangia borne on special leaves. But they have no cones.

2·2. *Cycadeoideae* (*Bennetitales*).—This is a group of trees with leafy sporophylls and has strobili looking like flowers.

2·3. *Pentoxylales*.—These were low shrubs with unilocular terminal sporangia short branches bearing appendages and microsporophylls. They are a unique group discovered in Rajmahal Hills by Professor Birbal Sahni in 1948.

The living members of Gymnosperms are generally grouped as below :—

2·4. *Cycadales* or *Cycads*.—This order comprises one family of 9 genera and 100 species, spread in dry tropical desert regions in the Old and New World. Some of them are endemic to Australia (*Macrozamia*, *Bowenia* and some *Cycas* species eg. *C.media*), South Africa (*Stangeria* and *Eneaphalartos*), South America (*Zamia*), and North America (*Microcycas*, *Dioon* and *Ceratozamia*). In India single genus, namely *Cycas* occurs of which 6 species are found in mountains, dry regions of Western Ghats, Assam, Sikkim, but none in Maharashtra. It occurs in Karnatak in Nag Mangala area and in Andhra Pradesh on Tirupati hills. They

have male and female plants with huge male cones studded with microsporophylls, and have fern-like pinnate leaves, but no female cones. Megasporophylls are in whorles below growing point of stem.

2·5. *Coniferales or Conifers.*—They have 48 genera and 520 species. They form dominant vegetation up to tree line and some even up to snowline in temperate regions. They are an important source of timber, paper pulp, terpentine and resin. 14 genera and 40 species occur in India. None in Maharashtra. A few are cultivated, e. g. Spp. of Cupressus, Agathis, Tatodium, Podocarpus, Araucaria.

2·6. *Ginkgoales.*—Ginkgoales are represented by a single surviving genus and a single species—not indigenous but cultivated in Asia. The only species *G. biloba* has leaves which look like those of the fern *Adiantum.* They have two curly lobes, and hence the species is called *biloba.* It is a tall deciduous tree. It grows sometimes about 36 metres high. It is called ' Maiden Hair Tree ', because of its curly leaves like the curls of a maiden.

2·7. *Gnetales.*—This is a small Order with three odd members *Gnetum Ephedra* and *Welwitschia. Gnetum*—is a liana or an under-shrub in Tropical jungles. It has about 34 species. The climbers are 25—40 metres long and shrubs about 5—8 metres high. Only *Gnetumula* occurs at Khandala and in forests all along Konkan and Malabar.

Ephedra.—This is a leafless desert shrub having about 35 species spread all over the world in sandy desert regions. It is a distinct woody climbing plant having separate male and female plants as in *Cycas. Ginkgo* or *Gnetum.* It forms thickets of male and female plants looking like *Euphorbia tirucalli.* It is distinctly a xerophyte.

Welwitschia.—This is a desert plant of West Africa in the desert region of Congo. It is a unique member having separate male and female plants with two large permanent strap shaped leaves growing continuously with the help of cambium situated at the base of the leaves. Sometimes they reach 6-8 metre length. The leaves are radical and beset on a large tap root. There are hardly 300 plants in the world of this fast dying genus. Some of these are now being cultivated in Portugal to save them.

3. Gymnosperms in Maharashtra

There are no wild *Cycads* or *Conifers* in Maharashtra. No conifers are also found wild, but some are cultivated. However the fossil flora of Wardha-Godavari valley has many fossil coniferous woods belonging to Permian to Jurassic age. In the Quaternary strata and sub-Recent alluvium of the valley of Godavari and Pravara rivers pollen grains of Conifers, especially of *Podacarpus* are found, suggesting thereby that they were present upto Quaternary period in Maharashtra.

Several Conifers and Cycads however are grown in gardens. The usually cultivated conifers are *Cupressus, Thuja, Araucaria* and *Pinus.* Occasionally *Taxus, Taxodium Agathis* are cultivated in Poona University Botany Department Garden, M. A. C. S. Garden, Pune, etc. Among the Cycads, *C. circinalis* Linn. *C. revoluta* Thumb. *C.* rumphii *Mig.* are grown for their beauty. In Fergusson College Botanical Garden, *Encephalartos* sp. and at M. A. C. S. Garden, *Zamia floribunda* DC are cultivated. *Ephedra* though does not grow wild in Maharashtra, *E. foliata* var *ciliaris* is common in Rajasthan deserts, in Cutch and Saurashtra.

The only gymnosperm wild in Maharashtra is *Gnetum ula* Brongn. It grows wild at places having high altitude in Western Ghats e. g. at Mahabaleshwar, Khandala, Matheran, Castle Rock, Goa, etc. It also grows near the coastal strips at Janjira, Alibag, etc; nearly at sea level. It continues down right upto Malabar. At Trivendrum in Kerala another species *G. contractum* Mfg. is found. It is an erect 4-5 ft. tall shrub. On the other hand, *Gnetum ula* is a huge woody climber producing male and female plants with distinct; strobili in clusters; e.g. at Khandala, Matheran, etc. This rare plant has been conserved because the places where it grows are not easily accessible or because it occurs in Devrai woods where cutting of plants is prohibited. Therefore, this plant has escaped the axe of an indiscriminate woodcutter.

Some efforts to cultivate conifers in Maharashtra are now being made with a fair amount of success. Some species of *Pinus*, *Agathis*, *Cupressus*, *Araucaria* can easily be introduced in the hills at high altitude in Maharashtra. *Agathis australis* and *Pinus longifolia* do well at Panchgani, and *Cupressus* species at Mahabaleshwar, Chikhaldara, etc.

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CHAPTER VI—ANGIOSPERMS: FLORISTIC SURVEY AND ANALYSIS

CONTENTS

CHAPTER VI—ANGIOSPERMS

1. Floristic Survey and Analysis—Botanical Regions of India

Angiosperms or the Flowering plants form the largest and the most conspicuous group of plants in the world. They number about 250,000 having about 300 families and range from the smallest plant like *Wolffia* measuring hardly 1/10th of a cm to the largest ones like Banyan (*Ficus bengalensis*) spreading over an acre at Indian Botanical Garden, Calcutta, to the tallest Australian Eucalypti.

They are found from tropics to Sub-arctic region. India has much varied flora and fauna extending from Kashmir to Kanyakumari. It varies from Alpine mountain flora in Kashmir to dry deciduous forests of Peninsular India. There are vast differences in topography, soils and altitudinal heights. Maharashtra lies between 15° 35′ and 22° 2′ North Latitude and 72° 45′ and 80° 35′ East Longitude and has not so much of variation. The highest peak of mountains in it the Sahyadries, is Kalsubai near Igatpuri. It is at an altitude of about 6300′ (1915 mtr.). Naturally there is no Alpine vegetation at such a low height, vegetation like that below the snow line, or that near the timber line. Whatever the differences in the vegetational pattern are there they are due to nearness to sea, or on account of the topography of the table-land of Deccan. Much of it lies above the M. S. L. 1200′ to 2000′.

The physical features naturally divide the State into five large natural floral sub-units or zones: (1) Konkan strip adjacent to Arabian sea, (2) Mountainous terrains of Sahyadries or the Ghats region, (3) Desh forming a flat plain to east, with side off-shoots of ranges of Sahyadris (4) Khandesh at the north with low hills of Satpura and (5) Vidarbha including Nagpur, Bhandara, Chandrapur, Amravati, Akola, Buldhana districts. It receives both the monsoons, South-West and North-East right down upto Alapalli forests in Chandrapur district. This region is cut across by Pench, Wardha, Vainganga and Pranhita rivers and their tributaries.

The difference in the flora of these regions is mainly due to rainfall, temperature, humidity, soils and topography. They are also due to historical reasons as shown later. The plants from the Indoganga plains reach as far south as Khandesh, the Tapti and Narmada basins, and those from Gujarat enter at the North ; those from Malabar at the south reach south Konkan and Dangs. The forests of Chandrapur district are adjacent to Andhra Pradesh and Madhya Pradesh, and those in Khandesh are adjacent to South Gujarat and Madhya Pradesh. Naturally the flora gets mixed up in such border regions.

The Maharashtra flora gets further its floristic features due to narrow upland valleys of Maval and Dangs. These are isolated low lying narrow valleys of Sahyadris, and from nitches created by the Sahyadri ranges with their distinct climatic and edaphic factors. Maharashtra once upon a time was a thickly wooded part of ' Dakshina Path ' and the Dandakaranya. Only some remnants of them are seen in the flora of Maharashtra. The present flora is successor to the Tertiary flora of Deccan as screened by the successive changes of climate which was dry in Miocene and cold in Pleistocene. The early floras had temperate elements in them, the conifers and members of the Rosaceae. They have disappeared. The present flora of the Desh, Vidarbha and Nagpur region including Chandrapur, is of monsoon deciduous type. The other elements are there, but they do not occupy very large areas.

Hooker (1855) has divided the then British India into 9 botanical regions of which 7th is Sri Lanka and Maldiv Islands, the 8th Burma, and the 9th Malayan Peninsula. They are now different countries. Thus there remain only 6 main botanical divisions of India. Calder (1937) also recognized 6 botanical provinces of India, namely (1) North-Western Himalayas which are rather high and relatively dry, (2) Eastern Himalayas, not so high, but more humid, (3) Indus plain covering Indus basin and the Rajputana desert, (4) Flat Indo-ganga plain formed by the rich alluvium brought down from Himalayas by Ganga, Yamuna and Brahmaputra, (5) The Deccan plateau with a Eastern sub-province the Eastern ghats region in Andhra Pradesh and Orissa and (6) Malabar.

Maharashtra belongs to the 6th division of Hooker (1853) and to the 5th division of Calder (1937). Deobrata Chatterjee (1960) reconsidering the whole position revised these, mainly on the basis of the Endemic Flora which was more or less not known to or fully recognised by Hooker. He divided India into Seven Botanical provinces, except Andamans which forms the 8th separate Botanical province.

Botanical Regions of India according to Hooker (1898), Clarke (1898), Chatterjee (1960) and Calder (1937) are as follows :—

J. D. Hooker (1898) (1)	C. Calder (1937) (2)	C. B. Clarke (1898) (3)	D. Chatterjee (1957) (4)
2. Western Himalayas. ..	1. North-Western Himalayas.	1. West Himalayas	8. Western Himalayas.
3. Indus Plain ..	2. Eastern .. Himalayas.	2. Indian Desert ..	3 Indus Plain.
5. Malabar ..	3. Indus plain and Rajasthan Desert.	3 Malabar	2. Malabar.
7 Ceylon and Maladiv Islands. ..	4. Indo-Ganga Plain. ..	4. Sri Lanka ..	1. Deccan.
6. Deccan ..	5. Deccan Plateau with sub-province of Eastern ghats. ..	5. Coromandalia..	4. Gangetic Plain.
4. Gangetic plain. ..	6. Malabar including Konkan. ..	6. Gangetic plain	6. Eastern Himalayas.
1. Eastern Himalayas. ..	.. ..	7. East Himalayas.	5. Assam.
8 Burma ..	.. ..	8. Assam ..	7. Central Himalayas.
9. Malayan Peninsula. ..	.. ..	9. Ava ..	9. Upper Burma.
		10. Pegu ..	10. Lower Burma.
		11. Malayan Peninsula.	

Hooker (1855) has estimated 17,000 species of flowering plants in British India spread over 170 families, besides 600 species of Ferns and Fern allies. These have been variously estimated by different authors like Santapau (1958), Maheshwari (1965), etc. The Deccan Peninsula of which Maharashtra is a large part is relatively a dry elevated table-land, and it is a part of the most ancient Indian continental land mass —the Deccan Peninsula. It has never been under sea and is not affected much by the subsequent changes of terrain due to tectonic movements that took place to its north, elevating the Himalayas, drying up of Tethys, filling up the Indo-gangetic plain by debris from the Himalayas, formation of Indian desert of Rajasthan and Thar Parker etc. The only conspicuous changes in it are due to repeated submergence and elevation of land on its western and eastern coasts—the Arabian sea coast and the Coromandal coast on its east, the sea incursing on the land of Konkan, Saurashtra and Andhra Pradesh more than 2-3 times, and subsequent submergence of West Coast. This has naturally resulted in the climatic changes. The Deccan terrain developed somewhat easterly slope and the rivers therein easterly trend. There is slight elevation towards north. But no great upheavals were there. The flora, therefore, largely remained more or less steady except that some species migrated from one area to another. The temperate species migrated north ; and a few Alpine herbs remained confined to high lands of Sahyadris, Vindhyas and the Eastern ghats.

There are no authentic Floras of Madhya Pradesh, Karnatak or the Marathwada region. Some parts of it are now included in Maharashtra. The only authentic work even today is "*The Flora of the Bombay Presidency*" by Theodore Cooke (1904-1908). He has described 2530 species belonging to 142 families, but this needs revision.

There is no Flora of the Nag-Vidarbha region nor of Marathwada districts. Only some hand lists of Vidarbha region by Witt (1908), Graham (1911), Haines (1912-1914, 1916), Hewstson (1951), Mirashi (1966), Balapure (1960) and the recent Forest Flora of Melghat by Patel (1968) are available. We shall, therefore, consider here such information as is available and base our tentative conclusions on it. But they should not be considered as final and may have to be revised or modified in subsequent years.

Plants of Marathwada have been given in *Forest Flora of Hyderabad State* by Sharfuddin Khan (1953), by M. Sayeed-ud-din in his various papers, especially in his Presidential address to Botany Section of Science Congress (1954), in Tilak's (1967) *Flora of Aurangabad District,* and in the *List of Herbarium* at the Botany Department in Marathwada University (1969), and in papers of Naik (1978). These contain only partial references to them.

2. Constituents of the Flora of Maharashtra

The newly constituted Maharashtra State (1979-80) includes 8 districts of Vidarbha, 5 districts of Marathwada newly added : it excludes the whole of Gujarat, and the districts of Bijapur, Belgaum, Dharwar and North Canara. The Maharashtra flora is heterogeneous in composition. However upto Belgaum and even beyond, in Khandesh, the Deccan traps continue right into Madhya Pradesh and South Gujarat. Therefore, it can be easily divided in sub-regions the Nag-region formed by Nagpur, Bhandara, Chandrapur districts, the plateau of Vidarbha composed by Wardha, Amravati, Yeotmal, Akola and Buldhana districts,

14 districts of Western Maharashtra with high regions of Sahyadri, and the long narrow coastal strip of Konkan. Since the physiography, climate and soil conditions in these different regions are different their flora also differs. Hooker (1855) has put some of them in different botanical provinces. For example, Konkan has been linked with Malabar, Khandesh has been made into a separate sub-unit, and the rest into another botanical province. The reason why Khandesh has been separated as a distinct botanical sub-province is due to its geographical situation. It is lying to the South of Satpudas and is drained by Narmada and Tapi. Similarly Maval is treated as a distinct sub-unit due to its upland valleys and climate therein.

3. Previous Work on Bombay Plants by Workers before Theodore Cooke

The flora of the earstwhile Bombay Presidency has been worked out by several authors and there is quite an amount of information available which Cooke (1908) incorporated into his well-known '*Flora of the Bombay Presidency*'. It is still the authoritative Flora of this region, but as it contains plants of Sindh, Gujarat, North Canara, Bijapur, Belgaum and Dharwar and exclude the plants of the five Marathwada districts, it is incomplete and out of date. The figures and conclusions therefore we shall draw will only be tentative. After the publication of Cooke's Flora several papers dealing with the plants of this region by Blatter and his associates, Santapau and his students, G. L. Shah, Mirashi, Razi, Vartak, S. K. Jain, Puri, R. S. Rao, Balapure and others and by the members of Botanical Survey of India have appeared. Even before Cooke, hand lists of Bombay Flora were published by Woodrow, Gammie etc. But more comprehensive than those were two studies by Dalzell and Gibson's '*Bombay Flora*' (1861), and the *Flowering Plants of Western India* by A. K. Nairne (1894). However these had their own limitations and have become outdated.

4. Early Works on Bombay Flora

This region of Western India upto Goa has been much explored by various foreign botanists from time to time dating from Garcia de Orta (1563) to Cooke (1908). References to South Konkan Flora were also made by Henrique Van Rheede (1660-1699) in his famous work of the Pre-Linnean period, "*Hortus Indicus Malabaricus*". Plates illustrating some plants of this region in this work have been included in "*Species Plantarum*" by Linnaeus (1753). Roxburgh's *Flora Indica* (1832) also contains references to them. But works on the plants of Vidarbha region are extremely scanty. Graham's (1911) list of 250 plants of Nagpur, and Telankhedi tank is published and the one earlier by Witt (1908). Some workers have been recently collecting and writing stray articles on the plants of that region. Patel (1968) has written "*The Forest Flora of Melghat*" in District Amravati. It contains short description of 716 plants in the hilly regions of Vidarbha, Melghats and Chikhaldara. The flora of Chandrapur and Akola and other districts are under study by the Botanical Survey of India.

5. Flora of other Regions in Maharashtra

Regarding the flora of Marathwada region, a hand list of 679 plants is published by Botany Department of Marathwada University (1974) '*Flora of Aurangabad District*' by Tilak (1961) is another work. The flora of Osmanabad district has been worked out by Dr. V. A. Naik but is yet to be published. The late Professor M. Sayeed-ud-din and his

colleagues at the Osmania University have worked on many plants of this region here and there and have described them in their papers. However, there is no account of plants of the hilly region of Ajantha or Kinwat. Sharfuddin (1953) has published a *Forest Flora of the Hyderabad State* which includes description of the plants from Marathwada districts and also of Telangana not in Maharashtra. We have, therefore, to be satisfied with what little published literature is available.

According to Blatter (1908) there were 2,536 species spread over 142 families in the old Bombay Presidency. This is not a small number as rightly pointed out by Father Blatter (1908) in view of the whole Flora of British India composed of 170 families and 17,000 species. Out of these 142 families in Bombay Presidency, 22 families are having only two genera and 42 families having only one genus. Of these 20 contain only one species each. They are :

1. Magnoliaceae
2. Papaveraceae
3. Fumaricaceae
4. Ancistrocladaceae
5. Chailletiaceae
6. Ilicaceae
7. Sabiaceae
8. Saxifragaceae
9. Haloragidaceae
10. Passifloraceae
11. Datiscaceae
12. Araliaceae
13. Hydrophyllaceae
14. Illeceberaceae
15. Thymeleaceae
16. Elaeagnaceae
17. Balanophoraceae
18. Ceratophyllaceae
19. Xyridaceae
20. Flagellarieceae.

The largest families in this region are Leguminoceae and Gramineae each having more than 250 species. The families when arranged as per their number of species would be as follows :—

1. Leguminoceae
2. Gramineae
3. Acanthaceae
4. Compositae
5. Euphorbiaceae
6. Cyperaceae
7. Rubiaceae
8. Orchidaceae
9. Malvaceae
10. Convolvulaceae
11. Labiatae or Lamiaceae
12. Asclepiadeceae
13. Scrophulariaceae
14. Urticaceae
15. Tiliaceae
16. Boraginaceae
17. Commelinaceae

The flora of Malabar extends into Konkan. Here the plants from the Vindhyan and Indo-ganga plains meet those in Khandesh and in Narmada basin. Comparison, therefore, can usefully be made with the flora of those regions. The greater part of Deccan Tableland is nearly above 2000′(610 mtrs.) from M. S. L. Maharashtra Flora has to be compared with the flora of the whole of Deccan Peninsula. Here the topography changes from hilly regions to plains with black cotton soil spread all over Maharashtra, Madhya Pradesh and South Gujarat. There is

great similarity between the plants of these three regions and those adjoining. As we go south there are progressively higher rainfall and humidity. The humid species go on increasing more and more towards south and west. It is because of this that the Western ghats or Sahyadri regions of Belgaum, Dharwar, Harihar, Kadur districts have rich vegetation of moist deciduous forests and even some ever-green species not to be seen in Maharashtra plains. On the other hand, the northernmost part of the Deccan trap lies in Gujarat. The isolated peak of Pavagarh hill in Gujarat is of Deccan trap origin but rather dry; here the humid species give way to dry deciduous species. There is also a strange resemblance between the flora of Assam and flora of Maharashtra as shown especially by the grasses which are the second most dominant family in Maharashtra. This is accounted for, among other reasons, as due to soils and to migration of species along the Garo hills, Vindhyas, Satpuras right down to Malabar *via* Sahyadris. They form a route for the migration of species from Malaya to Burma, Burma to Assam, Assam to Garo, Garo to Vindhyas and Satpuras and thence to Konkan down to Malabar. Because of this, there is similarity between the species of Malabar, Assam and Malaya e.g. species of *Lilium* like *L. nilgirenae*, grow in Eastern Himalayas and Nilgiris. This problem was very extensively studied with the help of fauna and flora by the late Dr. Sundarlal Vora who formulated his well-known '*Satpura Hypothesis* for the migration of species across the continent of India from east to west and thence to south through Satpudas. We shall consider it later again,

The Junagarh hill, Girnar Parvat and Barda-dongar have vegetation of species more or less similar to those in dry parts of Maharashtra and Deccan. It is essentially of dry deciduous type, but is not protected by the high wall of Sahyadris as that in Konkan. The vegetation, therefore, presents a dry and drab appearance for the most part of the year,but produces green verdure of the herbaceous flora in the monsoon and in post-monsoon period as in Maharashtra. The deciduous forests of Girnar produce greenery allround. The flora of Saurashtra resemble with the flora in deciduous forests on the Desh side, and that in drier parts of Konkan like Deogad.

Khandesh is treated as a separate Botanical sub-province. It is rich in alluvial soils and gets moderate rains . Its comparison can be made with flora of South Gujarat and Madhya Pradesh. Nearness of sea is an additional factor which gives it more humidity. But in summer months, it is very dry like that in some districts of Vidarbha.

Hooker (1855) has drawn special attention to the flora of Maval region. We have seen in earlier part that these are the upland narrow valleys generally having altitude between 2000' (610 mtrs.) or more, often drained by a river or hill stream. There is constant moisture in the atmosphere. Soils are shallow and well irrigated and drained being on hill slopes. The flora in the valleys is protected by the hill ranges, but remains isolated from the flora of the rest of Maharashtra and that in other Mavals. As such it develops special character of its own like the vegetation and flora of *Sholas* in Nilgiris. Only difference is that they do not have very high altitude as that of *Sholas* in Nilgiris. They contain some montane and rare species and some endemics. Being thickly wooded, they were once upon a time of great strategic importance but indiscriminate hand of man has cut down much of vegetation in them. However, some rare species are preserved only in isolated pockets in them and in the conserved groves of trees dedicated to Gods known as the 'Deorais'.

6. Comparison of the Maharashtra Flora with the Flora of adjoining Regions

The characteristics of flora or vegetation are brought out by: (i) comparison with flora of adjoining territories, and (2) by the study of endemic plants found in them. The principal dominant families of Maharashtra are given on page 284. It will be seen that the Leguminoceae is the largest family, Gramineae, Acanthaceae and Compositae come next. The principal dominant families of the Deccan Peninsula and Malabar are the Gramineae, Leguminoceae, Acanthaceae, Orchidaceae, cyperaceae, Euphorbiaceae, Rubiaceae, Compositae, Labiatae, Asclepiadeceae. It will be seen that in the flora of Deccan Peninsula and Malabar the Gramineae is more predominant, Leguminoceae occupying second place; Acanthaceae which consists of mostly shrubs and herbs occupy the third place in both. Compositae with its 98 species occupies the 8th place in Malabar flora, 4th and 5th places are taken by the Orchidaceae and Euphorbiaceae. It is well worth noting that Orchidaceae is rather poorly represented in Maharashtra flora. Families Euphorbiaceae, and Cyperaceae and Rubiaceae occupy nearly the same position except that Cyperaceae are more numerous than Euphorbiaceae in the Malabar flora. Abundance of Cyperaceae suggest more humid and marshy conditions in Malabar, whereas more of Euphorbiaceae suggests drier habitats. Malvaceae is quite abundant in Maharashtra, but is very poorly represented in Malabar. Blatter (1908) has further compared the Bombay flora with the flora of Sri Lanka which is in tropical region. In that region Gramineae is the first dominant family. Leguminoceae the second, and Orchidaceae the third, Compositae, Urtinoceae and Melastomaceae come next in succession. Obviously the Malabar flora has more in common with the flora of Sri Lanka than that in Maharashtra which is very much dry compared to Malabar. Therefore its comparison with the flora of the Southern part of Deccan Peninsula, Malabar and Sri Lanka is not appropriate. The Maharashtra flora flourishes under semi-arid conditions and it practically lacks members of Melastomaceae and has preponderance of drier species. The only partial exception to this is the flora of Konkan and of the Ghat regions of Sahyadris. The flora of Southern Gujarat is comparable with the flora of Maharashtra.

In order to appreciate fully these remarks, it is necessary to know and comprehend the flora of the individual constituents of Maharashtra. These are considered here in next pages.

The endemic element will be considered separately later. It is represented by about 42 species in Maharashtra and it gives character to its flora.

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SECTION A—FLORA OF MARATHWADA

CONTENTS

SECTION A—FLORA OF MARATHWADA

1. The Region

Aurangabad adjoins Jalgaon, Buldhana, Jalna, Ahmednagar and Nasik districts. Jalna, newly created district, adjoins Aurangabad, Buldhana, Parbhani and Bhir. Parbhani is surrounded by Jalna Akola, Yeotmal, Nanded, Latur and Bhir. Nanded is adjoining Latur, Parbhani, Yeotmal districts and Andhra Pradesh. Latur is adjoining Osmanabad, Bhir, Parbhani, Nanded, and Andhra. Osmanabad adjoins Sholapur., Ahmednagar, Bhir, Latur and Andhra.

Naturally the climate and flora of adjoining dry districts of Ahmednagar, Sholapur and Akola have a strong influence on the climate and flora of Marathwada. Kannad ghat joins Marathwada to Khandesh. The plants of these regions are given in the lists that follow. The plants of Ajantha are dry deciduous growing on hill slopes. They contain woody species such as *Tectona grandis, Boswellia serrata, Terminalia chebula, Anogeissus latifolia, Dalbergia latifolia*, etc. The Kannad ghat in no way compares with the moist deciduous types of Western ghats, which are richer in species than here. The species found are the same as in Nasik and Khandesh districts. The characteristic plants of dry ghats are *Capparis horrida, Cochlospermun gossypium, Flacourtia montana* and also a few semi-moist species such as *Thespecia lampas, Wagatia spicata.* The plants of Kinwat consist of a few characteristic species of higher rainfall region especially in rainy season, but the rest are all scrub as in Nasik hills, as the rains last for a few days, followed by a long dry spell.

The lists of species (5—8) show species found in Cooke's *Flora of Bombay Presidency*, but it also shows a large proportion of plants from the sandy regions of Telangana and neighbouring regions, having had come here. However, it is very likely that as more exploration will be made it may not remain the same and, therefore, we shall not comment more on them here.

2. Climate of Marathwada

1. *District Aurangabad*[1].—The climate of this district is characterized by hot summer and general dryness throughout the year except during south-west monsoons in June to September. The post-monsoon period is October to November. Average annual rainfall in Aurangabad is 725.8 mm. (29"). About 83 per cent of the rainfall is during June to September. July is the rainiest. Rainy days are 45. Cold weather begins by the end of November when the temperature falls rapidly. December is the coldest month. Mean daily maximum temperature is 28.7°C (83.3°F). Hottest months of the year are May-June when the mean daily maximum temperature is 39.8°C (103.6°F) and the mean daily minimum 24.4°C (75.9°F). Daily high temperatures decrease progressively with the withdrawal of monsoons In October, winds are light to moderate. During monsoons they blow West to North. Normal annual rainfall is 725.8 mm. and rarely more. 32.5°C is the annual mean maximum temperature and annual mean minimum is 19.7°C. Relative humidity is 0830 –1730 IST. Wind speed annual mean is 11.8 KPH.

2. *District Bhir* (*Beed*).—Climate of this district is dry. Cold season is December to February. Rainy days are 41. December is the coldest

[1] Separate details for newly created district of Jalna are not available.

month. Wind blows north-westernly. In May mean daily temperature is about 42°C (107.6°F), but may be as high as 46°C (114.8°F). Daily temperatures begin to increase slightly from the 1st week of October with a secondary maximum in October and humidity is less than 30 per-cent.

3. *District Osmanabad* [1].—Climate of the district is dry,except in monsoon—June to September. Post-monsoon rains come from October to November. The average annual rainfall is 988.2 mm. (39.5") Rainiest month is July. Average rainy days are 51. Period from middle of February is generally hot. In hottest month mean daily maximum temperature of 40.°C (104°F) and daily minimum about 25.°C. (77.°F). Afternoon thunder showers bring the temperature down, Temperature drops in June with the onset of monsoons. From October, daily temperature begins to increase but the nights become progressively cold even during monsoons. From October to December winds blow north-east to south-east. In May they blow west to north. Rainfall in this district is better distributed than in other districts.

4. *District Nanded.*—The climate of this district is generally dry except in monsoons. The cold season is November to February. Hot season is from March to first week of June. South-west monsoon is from June to the first week of October. Average rainfall is 897.8 mm. (36"). Heavy rainfall is generally in August. Night temperature begins to fall at the end of November. The coldest month is December. Mean daily minimum temperature is 13.°C (55.4°F) and maximum 29.0°C (84.2°F). Cold waves from North India blow west to north. Day and night temperatures continue to rise from March to May. The hottest month of the year is May with 42 °C (107.6 °F), but with the advance of monsoon both go down. There is a slight secondary rise in October, after which night and day temperatures decrease. In monsoon 80 per cent of rains come, but in other months of the year there is very little rain, hardly 20 per cent. Winds blow south-west to north-west in monsoons.

5. *District Parbhani.*—Climate is generally hot from March to May. Average rainfall is 888.5 mm. (34.98"). Rainy days are 45. The number varies, at Hingoli they are 41 and at Parbhani 48. Maximum temperature is 29.30 °C (94.7 °F). Minimum is 12.6 °C (54.5 °F). Minimum sometimes falls as low as 5-6 °C (41 °F). Temperature is hottest in May. Weather is pleasant throughout monsoons till the last week of October when temperature begins to drop gradually. Highest maximum at Parbhani recorded is 45.9 °C (114.1 °F) generally in May. Lowest is in January as low as 4.4 °C (39.9 °F). Relative humidity except in monsoon is less than 30 per cent. Winds are north-west in cold season.

It will be seen that the climate of Marathwada on the whole is quite hot and dry. But pleasant is the district of Aurangabad as the night temperatures fall and weather becomes cool and pleasant. It is hot, but not so hot as in Vidarbha districts.

The flora of a place is determined primarily by the climate and then by edaphic factors. The climate here permits growth of dry deciduous species, especially as the rainfall is uncertain and lasts only for a short duration. The gravelly soils are unfertile, only thorny shrubs develop on them. However where the river Godavari flows or the lakes abound, the soils are alluvial, but the weather is severe. The flora therefore tends to be different in different places.

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[1] Separate details for newly created district of Latur are not available.

We shall now consider the flora. A consolidated list of plants compiled from the literature available is given in list 5, and the list 6 notes the plants from Ajantha. List 7 gives plants of Kannad Ghat and list 8 of Kinwat. In them there are many plants not given by Cooke (1908) in his *Flora of the Bombay Presidency.*

It will be seen that about 769 plants belonging to 99 families are so far known. A large number of them are herbaceous and preponderant. Therefore, the monsoon flora looks striking throughout Marathwada districts.

3. General Remarks on Flora of Marathwada

The Six districts of Marathwada lie in the basins of rivers Godavari and Purna which is its tributary, Flora has developed in their basins. Of these, the flora of Aurangabad district is known in detail. But that of other districts, is not known. Sharfuddin Khan (1953) has written on the *Forest Flora of (erstwhile) Hyderabad State,* made up then of Kannad area, Telangana and Marathwada. He has included about 198 species from Marathwada region as were known then. But like all other Forest Floras it has its own limitations. These 198 species are spread over 63 families and 141 genera. Tilak (1963) in his '*Flora of Aurangabad District*' has described 1335 species belonging to 120 families of Angiosperms, Ahilya Jagatap (1965, 1966) in her articles on Marathwada Flora has described 312 species. Recently Naik (1978) has published a booklet '*Keys to the Angiosperm Families of Marathwada*'.

These families, arranged broadly as per number of species known, are:—

1.	Leguminoceae	99
2.	Gramineae	55
3.	Compositae	33
4.	Euphorbiaceae	33
5.	Labiateae	20
6.	Scrophulariaceae	16
7.	Apocynaceae	15
8.	Cyperaceae	12
9.	Commelinaceae	9
10.	Liliaceae ..	9

The ratio of Dicots to Monocots is 4 : 1. From the list of plants in the flora of Aurangabad, it will be seen that this flora and also of Bhir and Osmanabad districts is essentially a flora of dry, semi-arid region. It is a thorn savannah, the same as in the neighbouring districts of Ahmednagar and Sholapur. The reason for this is that Aurangabad is contiguous with the dry districts of Ahmednagar and Bhir, the major part of Osmanabad district and with the extreme dry part of Sholapur district. It is, therefore, a scrub, or thorn savannah. Only the small hilly region of Ajantha and Kannad to the north-west of Aurangabad, the region around Aurangabad, Daulatabad, Kinwat have low hills. From Ajantha 53 species have been recorded and from Kannad ghat 126. From Kinwat however only 31

species are known. They have deciduous forest species and scrub which are similar to those in the dry deciduous forests of Maharashtra. At Kinwat however, and in parts of Osmanabad district there appears to be a mixture of shrubs and herbs from Maharashtra and Andhra Pradesh. This makes the monsoon flora look different.

On the whole, the flora of Marathwada developed on the Deccan trap hills and soils, with about (20-25″) 508-635 mm. of rain and (1000-2000′) 304-610 metres altitude and flat terrain dotted with low barren hills, is of the same type as that of very dry parts of Maharashtra. It is only the herbaceous flora of places like Osmanabad, Kinwat and Nanded that it is a little different due to contiguity of the sandy region and plants of Telangana, especially in Adilabad district, and of Gulberga district in Karnatak.

The forests on the slopes of Ajantha on Satmala range are similar to the dry deciduous forests of Khandesh and Ahmednagar. The hill flora of Parali Vaijnath is similar to the flora of the low hill of Ramling in Sholapur district. Flora of Aurangabad low hills is similar to the flora of Ahmednagar and surrounding hills.

The characteristic plants of Marathwada region are : *Prosopis spicigera, Hardwickia pinnata, Erythroxylon monogynum, Balsamolendron mukul, Litsea polyantha, Phyllanthus reticulatus, Ficus tsisela, F. infectoria, Smilax macrophylla, Balanitts roxburghii, Leea aspera, Capparis divaricata, Kadaba indica, Zizyphus nummularia, Ventilago calyculata.* Many of these plants are not found in soils derived from grantic and calcarious soils of Telangana. All these are the plants which belong to scrub jungles. They indicate a very dry and hot region. In this connection, the temperatures at a number of places in Marathwada districts are worth noting for comparison with Sholapur, and Ahmednagar. They are as hot as some of the places like Jalgaon in Khandesh or Akola in Vidarbha. But the rainfall is well distributed and winter temperature low due to which the climate becomes good for Rabi season crops, especially jowar.

4. Flora of Hilly Regions of Kinwat, Ajantha, Kannad and Aurangabad

Observations on the plants of hilly regions of Kinwat, Ajantha and Kannad ghat are listed in Lists 6-8. It is obvious that there are more herbaceous representatives. The species of trees are few e. g., *Adina cordifolia, Hamiltonia suaveolens, Dalbergia paniculata, Bauhinia lanzan, Terminalia paniculata.* Monocots also are few. A species of Orchids, *Vanda tesellata* is known only from Kinwat. It is obvious that this place in the rainy season is humid, otherwise dry.

A list of plants of Ajantha shows that the majority of species here are the same as on the low hills of Nasik, Khandesh and Ahmednagar. The following species are common to Western Maharashtra hills and Ajantha hill slopes, *Terminalia chebula,* T. arjuna, *Anogeissus latifolia, Dalbergia latifolia.* There are *large* stands of Rosa-oil grass *Symbopogon martini.* It contains a few plants slightly different but their number hardly exceeds 12. For example *Nyctanthes arbortristis, Wrightia tictoria,* are very distinct here than in the deciduous forests of Western ghats.

The Kannad ghat, on the other hand is richer in species. They are similar to those that are found in the ghats of Nasik and Khandesh districts. Characteric plants of such dry ghats are *Capparis horrida,*

Flacourtia montana, Cochlospermum gossypium. At the same time plants like *Kydia calycina, Thespesia lampas, Impatiens parviflora, Wagatia, spicata, Bauhinia vahlii, Melastoma Xeromphis spinosa, Olea dioeca, Mallotus rariflora, Habinaria marginata* (which are two tropical ground orchids) are characteristic of high rainfall moist region of Western ghats. They are also found here in Kannad ghats. However the soils in the Kannad ghat being poor, there is mixture of dry hilly species and some humid species. In this they differ from typical ghat forests in Sahyadries.

5. List of Plants From Marathwada

Name	Flowering season	Locality
Family Ranunculaceae :		
Clematis gouriana Roxb. ..	Cold weather ..	Mahadeo hills
C. triloba.		
Family Dilleniaceae		
Dillenia pentagyna Roxb. ..	June-July ..	Mahadeopur, Godavari forest
D. indica Linn. ..	June-July ..	
Family Magnoliaceae		
Michelia champaca Linn. ..	April—June ..	Cultivated
Family Annonaceae :		
Artabotrys odoratissimus R. Br. =*Artabotrys hexapetalus.*		
Polyalthia cerasoides Benth and Hook.	April ..	
P. longifolia Benth and Hook. f.		
Annona squamosa Linn.		Cultivated
Annona reticulata Linn.		
A. muricata Linn.		
Millusa velutina Hook. f. and Th.	May	Godavari forest, Mahadeopur.
Cananga adorata	September-October	Nanded (cultivated).
Family Menispermaceae :		
Cissampelos pariera Linn. ..	September-Oct.	Osmanabad, Aurangabad.
Cocculus villosus DC. .. =*C. hirsutus* (L.) Diels.	February—March	Marathwada
Cyclea burmanii .. =*C. peltata* (Lamk.) Diels.	January ..	
Tinospora cordifolia (Willd.) Miers.		
Family Nymphaeaceae :		
Nymphaea lotus Linn. ..	.. ..	Common in the State.
N. stellata Willd. ..	.. ..	Common throughout State.
N. nouchali Burm. f.		
Nelumbo nucifera Gaertn. ..	September—Feb.	Aurangabad

Name	Flowering season	Locality
Family Papaveraceae :		
Argemone mexicana Linn.		
Papaver somniferum Linn.	July—September	Osmanabad
Family Fumarieaceae :		
Fumaria parviflora	December—Feb.	Osmanabad
Family Cruciferae :		
Nesturtium officinale		
Eruca sativa		
Brassica juncea (Linn.) Cezern	August—Dec.	Osmanabad
B. nigra (Linn.) Koch	November—Feb.	Nanded
Iberis amara Linn.	September—Jan.	Aurangabad
Lepidium sativum Linn.	November—Jan.	Osmanabad
Raphanus sativus Linn.	October—Jan.	Osmanabad
Family Capparidaceae :		
Cadaba indica Lamk.	December—Feb.	Aurangabad
Capparis brevispina HK. f.	August—October	Osmanabad
C. decidua (Forsk.) Pax	July-August April—July	Osmanabad
C. divericata Lam.	March—July	Osmanabad
C. grandis Linn.	March—July	Osmanabad
C. zeylanica Linn.	March—July	Osmanabad
C. sepiaria Linn.		
C. horrida Linn.	January—March	
Cleome gynandra Linn.	June—December	Osmanabad
C. chelidonii Linn. f.	June—October	Osmanabad
C. simplicifolia Hk. f. and Thw.	July—November	Aurangabad
Crataeva religiosa Forst. = *C. narvalea* Buch-Ham.	April-May	Mahadeopur
Family Violaceae :		
Hybanthus suffruticosus (Linn) Bail. et Lan. —*Hybanthus enneaspermus* (Linn.) Muell.	August—October	Osmanabad
Family Bixaceae :		
Cochlospermum religiosum (Linn.) Alston.	February—May	Aurangabad
C. gossypium DC	December—April	
Bixa orellana Linn.		
Flacourtia indica (Burm.) f. Merr.	February—May	Aurangabad
F. montana Grah.	November-Dec.	
F. ramontchi L. Herit.	March-April	Hyderabad forest
F. sepiaria Roxb.		Aurangabad
Family Polygalaceae :		
Polygala bulbothrix Dunn.	August—Nov.	Ajantha
P. chinensis Linn.	June—January	Osmanabad
P. erioptera DC	July—October	Osmanabad
P. persicariaefolia DC	August—October	Aurangabad

Name	Flowering season	Locality
Family Caryophyllaceae :		
Dianthus chinensis Linn. ..	October—Jan. ..	Aurangabad
D. plumaris Linn.	September—Feb.	Aurangabad
Polycarpea corymbosa Lamk.	August—Nov. ..	Osmanabad
Vaccaria pyramidata Medik.	October—Feb. ..	Aurangabad
Family Portulaceae :		
Portulaca pilosa Linn. var. *hortualis* Linn. ..	October-Nov. ..	Osmanabad
P. quadrifida Linn.	September—Dec.	Osmanabad
Family Elatinaceae :		
Bergia ammanioides Roxb. ..	October—Jan. ..	Osmanabad
B. aestivosa W and A. ..	October—Jan. ..	Aurangabad
Family Pittosporeae :		
Pittosporum floribundum W. and A.	In cold season ..	Aurangabad
Family Tamaricaceae :		
Tamarix ericoides Rottl. ..	September—Dec.	
Tamarix dioica Roxb. ..	May-June	
T. gallica Linn. ..		
T. articulata Vahl. ..	May—Sept	
Family Guttiferae (Clusiaceae) :		
Calophyllum inophyllum Linn.	December-Jan.	
Mesua ferea Linn.	March ..	
Family Malvacae :		
Thespesia lampas (Cav.) Dalz and Gibs.	Rainy season	
T. populanea (Linn.) Soland	..	Hyderabad
ex Corr.	..	Aurangabad
Kydia calina Roxb.	At the end of hot season and in cold season.	
Bombax malabaricum ..	Cold season	
Eriodendron anfractuosum DC	January—March..	Aurangabad
Adansonia digitata Linn. ..	.. .. ..	Aurangabad
Abelmoschus crinitus Vall. ..	August-September	Nanded
A. ficulneus (Linn.) W and A	October—Dec. ..	Osmanabad
A. manihot (Linn.) Medik ..	October—Dec. ..	Osmanabad
Abutilon glaucum Cav. ..	October—Dec. ..	Osmanabad
A. hirtum G. Don.	October—Dec. ..	Osmanabad
A. indicum Sweet.	June—December	Osmanabad
Althea rosea Eav. ..	All the year ..	Aurangabad
Ceiba pentandra Gaertn. ..	December-Jan. ..	Aurangabad
Gossypium herbaceum Linn.	July—September..	Aurangabad
Hibiscus cannabinus Linn. ..	August—October..	Aurangabad
H. lobatus ..	September-Nov...	Aurangabad
H. micranthus Linn. ..	September—Jan...	Osmanabad
H. panduraeformis Burm. ..	September—Jan...	Osmanabad
H. rosa-sinensis Linn. ..	September—Jan...	Osmanabad
H. schizopetalus Hook. f. ..	September—Jan...	Osmanabad

Name	Flowering season	Locality
Malva sylvestris Linn. var. *mauritiana* Boiss,	December-Jan. ..	Aurangabad
Malvastram coromandelianum (Linn.) Garcke.	June-Jan. ..	Aurangabad
Sida acuta Burm. f. ..	August-Oct. ..	Osmanabad
S. glutinosa Cav. ..	Sept-Jan. ..	Osmanabad
S. spinosa Forsk. ..	Aug-Jan. ..	Aurangabad
S. veronicifolia Lam. .. —*S. cordata* (Burm. f.) Borssum.	July-Sept. ..	Osmanabad
Family Sterculiaeae :		
Dombeya acutangula Cov. ..	Jan-Feb. ..	Aurangabad
Eriolaena hookeriana W. and A. ..	Aug-Sept. ..	Beed,Aurangabad.
Guazuma tomentosa H. B. K.	Mar-Apr. ..	Aurangabad
Helicteres isora Linn. ..	Aug-Sept. ..	Aurangabad
Kleinhovia hospita Linn. ..	Dec-Jan. ..	Aurangabad
Melochia corchorifolia Linn.	Sept-Oct. ..	Western ghats
Pterospermum acerifolium. Willd. ..	Mar-May ..	Aurangabad
Sterculia urens Roxb. ..	Jan-Mar. ..	Nanded
Waltheria indica Linn. ..	Sept-Jan. ..	Aurangabad
Sterculia villosa Roxb. ..	Mar-Apr. ..	..
S. colorata Roxb. .. .. —*Firmana colorata* (Roxb.) A. Br.	Mar-Apr. ..	Aurangabad
Family Tiliaceae :		
Grewia tiliaefolia Vahl. ..	Apr-May ..	..
G. populifolia Vahl ..	Sept-Oct. ..	..
G. asiatica Linn. ..	Mar-Apr. ..	..
G. pilosa Lamk ..	Sept-Oct. ..	Aurangabad
G. salvifolia Heyne ..	Apr-Sept. ..	..
G. abutilifolia Vent. ..	Aug-Sept. ..	Osmanabad
G. hirsuta Vahl. ..	July-Sept. ..	Osmanabad
Corchorus aestuans Linn. ..	June-Sept. ..	Aurangabad
C. fasicularis Lamk. ..	Sept-Dec. ..	Osmanabad
C. olitorius Linn. ..	Aug-Nov. ..	Osmanabad
Corchorus trilocularis Linn.	Aug-Nov. ..	Osmanabad
Triumfetta rhomboidea Jacq.	Oct-Dec. ..	Aurangabad
T. rotundifolia Lamk. ..	Aug-Dec. ..	Osmanabad
Family Linaceae :		
Linum mysorense Heyne ..	Sept-Oct. ..	Aurangabad
L. usitatissimum Linn. ..	Sept-Oct. ..	Osmanabad
Hugonia mystex Linn. ..	..	Mahadeopur
Erythroxylon monogymum Roxb. ..	..	
Family Malpighiaceae :		
Hiptage madablota Gaertn. —*H. bengalensis* (Lam.) Kurz.	Cold season ..	..
Aspidopteris cordata A. Juss.	Mar-April ..	Aurangabad
Thryallis glauca Kurtzl ..	Sept-Oct. ..	Aurangabad

Name	Flowering season	Locality
Family Geraniaceae :		
Biophytlm helenae Busc. et Mush.	Sept-Feb.	Osmanabad
B. sensitivum DC.	Sept-Feb.	Osmanabad
Impatiens balsmina Linn.	Sept-Oct.	Aurangabad
Oxalis corniculata Linn.	June-Jan.	Osmanabad
Tropaeolum majus Linn.	Sept-Nov.	Hyderabad
Averrhoa carambola Linn.		
A. *bilimbi* Linn.		
Family Rutaceae :		
Murraya koenigii Linn.	Mar-Apr.	..
Limonia acidissima Linn.	Apr-May	..
L. eleutherandra Dalz.	Hot season	..
Atlantia monophylla Correa	Oct-Dec.	Warangal forest
Citrus medica Linn.		..
C. aurantium Linn.		..
C. decumana Linn.		..
Feronia elephantum Correa	Hot weather	..
Aegle marmelos Correa	Mar-May	..
Ruta graveo lens Linn.	Sept-Mar.	Osmanabad
Family Simaroubaceae :		
Ailanthes excelsa Roxb.	Feb-Mar.	Osmanabad
Balanites roxburghii (Linn.) Delile.	Nov-Mar.	Osmanabad
Family Ochnaceae :		
Ochna squarrosa DC	Mar-Apr.	Mahadeopur
Family Burseraceae :		
Boswellia serrata Roxb.	Apr-May	..
Garuga pinnata Roxb.	Hot weather	Marathwada
Balsamodendron mukul Hook f.	..	Berar and Khandesh.
B. caudatum	March	..
Family Meliaceae :		
Azadirachta indica A. Juss.	Feb-Apr.	Osmanabad
Melia azadirchta Linn.	July-Sept.	Osmanabad
Soymida febrifuga A. Juss.	Feb-May	Parbhani, Nanded.
Heynea triguga Roxb. =*Trichilla connaroides* (W. and A.) Benth.	..	Aurangabad
Cedrela toona Roxb. =*Toona ciliata* Roem.	..	Ajantha
Chloroxylon swietania DC	..	Not very common
Family Olacinaceae :		
Ximenia americana Willd.	..	Fairly common
Olax wightiana Willd.	..	Fairly common in Aurangabad
O. scandens Roxb.	..	

Name	Flowering season	Locality
Family Rhamnaceae :		
Ventilago denticulata Willd.	Nov-Jan. ..	Osmanabad
Zizyphus mauritiana Lamk.	Sept-Nov. ..	Aurangabad
Z. oenoplia (Linn.) Mill. ..	Sept-Nov. ..	Aurangabad
Z. trinervia Roxb. ..	Aug-Nov. ..	Aurangabad
Z. xylopyra Willd. ..	..	Common in forest
Family Vitaceae :		
Ampelocissus latifolia (Roxb.) Planch.	Aug-Sept. ..	Osmanabad
A. tomentosa Planch ..	June-July ..	Parbhani
Cayratia carnosa Gagnep. ..	Aug-Oct. ..	Nanded
Cissus pallida Planch. .. =*Vitis pallida.*	June-Aug. ..	Osmanabad
C. setosa Roxb. ..	Sept-Dec. ..	Aurangabad
C. vitiginea Linn. ..	Sept-Nov. ..	Osmanabad
Vitis quadrangularis Wall. =*Cissus quadrangularis.*	..	Common in hedges
V. latifolia Roxb. ..	..	Common climber in forest
V. pallida W. and A ..	..	Conspicuous shrub in dry rocky hills.
V. vinifera Linn. ..	..	Cultivated in Aurangabad.
Leea aspera Wall. .. =*Leea edgeworthii* Sant.	..	Under shrub
Family Sapindaceae :		
Cardiospermum halicacabum Linn.	Sept-Oct. ..	Osmanabad
Dodonea viscosa Jacq. ..	Oct-Dec. ..	Aurangabad
Sapindus emariginatus Vahl.	Oct-Nov. ..	Osmanabad
S. laurifolius Vahl.	Oct-Nov. ..	Osmanabad
Family Anacardiaceae :		
Mangifera indica Linn. ..	Feb-March ..	Osmanabad
Lannaea coromandelica (Houtt.) Merr.	Jan-Mar. ..	Osmanabad
Rhus mysorensis Heyne ex W. and A.	Jan-Aug. ..	Osmanabad
Semecarpus anacardium Linn.	Oct-Nov. ..	Osmanabad
Spondias mangifera Willd.	Feb-Mar. ..	Aurangabad
Buchanania latifolia Roxb.	..	Common in forest
Odina wodier Roxb. ..	..	Common and always in association with *Boswelia serrata*
Family Papilionaceae :		
Abrus precatorius Linn ..	Aug-Sept. ..	Osmanabad
Aeschynomene aspera Linn.	Oct-Feb. ..	Bhandara
A. indica Linn.	Oct-Feb. ..	Osmanabad

Name	Flowering season	Locality
Alysicarpus bupleurifolius DC.	Sept-Oct.	Osmanabad
A. longifolus W. and A.	Sept-Oct.	Osmanabad
A. pubescens Law	Sept-Oct.	Osmanabad
A. rugosus var. *styracifolius* Baker.	Sept-Oct.	Osmanabad
A. rugosus var. *heyneanus*-Baker. —*A. scariosus.*	Aug-Jan.	Osmanabad
A. tetragonolobus	Aug-Jan.	Osmanabad
A. vaginalis DC.	Aug-Jan.	Osmanabad
Arachis hypogea Linn.	Sept-Oct.	Aurangabad
Atylosia scarabaeoides Benth.	Aug-Oct.	Osmanabad
Butea monosperma (Lamk.) Taub.	Mar-Apr.	Osmanabad
Cajanus cajan (Linn.) Millep.	Oct-Jan.	Osmanabad
Cicer ariatinum Linn.	Dec-Feb.	Osmanabad
Clitoria ternatea Linn.	Oct-Feb.	Osmanabad
Crotalaria albida Hyena ex Roth.	Oct-Jan.	Osmanabad
C. filipes Benth	Aug-Oct.	Osmanabad
C. juncea Linn.	Aug-Oct.	Osmanabad
C. hirsuta Willd.	Aug-Oct.	Nanded
C. linifolia Linn. f.	Sept-Jan.	Osmanabad
C. medicaginea Lamk	Sept-Jan.	Osmanabad
C. mysorensis Roth	Oct-Dec.	Osmanabad
C. decasperma Naik	Oct-Dec.	Osmanabad
C. pusila Heyne ex Roth	Aug-Oct.	Osmanabad
C. retusa Linn.	Sept-Jan.	Osmanabad
C. trifoliastrum.	Sept-Jan.	Aurangabad
C. verrucosa Linn.	Aug-Oct.	Osmanabad
C. willdenoviana DC.	Aug-Oct.	Aurangabad
Cyamopsis tetragonoloba (Linn.) Toub.	July-Sept.	Aurangabad
Cylista scariosa Roxb.	Sept-Nov.	Aurangabad
Dalbergia latifolia Roxb.	Aug-Oct.	Osmanabad
Desmodium dichotonum DC.	Sept-Nov.	Osmanabad
D. gangeticum DC.	Sept-Nov.	Osmanabad
D. triflorum DC.	Sept-Nov.	Osmanabad
D. velutium (Willd.) DC.	Sept-Nov.	Osmanabad
Dolichos biflorus Linn.	Sept-Nov.	Osmanabad
Eliotis sororia DC.	Sept-Oct.	Aurangabad
Flemingia bracteata Wt.	Sept-Oct.	Aurangabad
Glycine max Merr.	Nov-Jan.	Parbhani
C. wightii (W. and A.) Verd.	Nov-Jan.	Osmanabad
Heylandia latebrosa DC. —*Goniogyne hirta.*	Jan-Dec.	Osmanabad
Indigofera barleri Gamble	Sept-Dec.	Osmanabad
I. cordifolia Heyne ex Roth	June-Jan.	Osmanabad
I. glandulsoa Willd.	July-Nov.	Osmanabad
I. glandulosa var. *sykesii* Roxb.	June-Nov.	Osmanabad
I. hirsuta Linn.	Aug-Oct.	Osmanabad
I. hoyer Forsk	Oct-Dec.	Osmanabad
I. linifolia Retz.	July-Dec.	Osmanabad
I. linifolia var. *lampbellii*	July-Dec.	Osmanabad

Name	Flowering season	Locality
I. linnaei Ali.	June-Oct.	Osmanabad
I. parviflora Heyne	June-Oct.	Osmanabad
I. pullchella Roxb. —I. *cassioides*.	Jan-Oct.	Aurangabad
I. spicata Forsk	Aug-Dec.	Osmanabad
I. tinctoria Linn.	Aug-Dec.	Osmanabad
I. trita Linn.	June-Nov.	Osmanabad
I. wightii Grah.	Aug-Jan.	Aurangabad
Lablab niger Medik	Oct-Dec.	Osmanabad
Lathyrus sativus Linn.	Dec-Feb.	Osmanabad
Medicago sativa Linn.	All the year	Osmanabad
Melillotus alba Lam.	Jan-Mar.	Aurangabad
M. indica All	Dec-Mar.	Osmanabad
Mucuna prurita Hook	Aug-Nov.	Osmanabad
Phaseolus sublobatus Roxb.	Aug-Oct.	Osmanabad
Rhynchosia minima DC.	Sept-Jan.	Osmanabad
Rhynchosia minima var. laxiflora Baker.	Sept-Jan.	Osmanabad
R. sericea Span	July-Sept.	Aurangabad
Sesbania bispinosa (Linn.) Grew.	Aug-Oct.	Osmanabad
S. sesban var. picta (Pr.) Sant.	Nov-Jan.	Osmanabad
S. grandiflora Dres	Nov-Jan.	Osmanabad
Shutaria sp.	Sept-Oct.	Aurangabad
Tephrosia hamiltonii Drumm.	Aug-Feb.	Osmanabad
T. hirt Ham	June-Sept.	Osmanabad
T. pentaphylla Sweet	Oct-Dec.	Aurangabad
T. purpurea pars	July-Jan.	Osmanabad
T. procumbena Ham	Aug-Oct.	Osmanabad
T. strigosa (Dalz.) Sant. et Mahesh.	July-Oct.	Osmanabad
Tetramnus labialis (Linn.) Spreng.	Aug-Oct.	Osmanabad
Vicia faba Linn.	Dec-Jan.	Aurangabad
Zornia diphylla (Retz.) Pers.	July-Dec.	Osmanabad

Family Caesalpiniaceae :

Name	Flowering season	Locality
Bauhinia purpurea Linn.	Oct-Jan.	Osmanabad
B. racemosa Lamk.	April-June	Osmanabad
B. tomentosa Linn. forma *concolor* DÇ. Wit.	Aug-Sept.	Osmanabad
B. variegata Linn.	Oct-Jan.	Aurangabad
Caesalpinia bonducella Flem.	Sept-Nov.	Osmanabad
C. decapetala (Roth) Alston	Sept-Jan.	Osmanabad
C. pulcherrima Gw.	Aug-Nov.	Osmanabad
Cassia absus Linn.	Aug-Nov.	Osmanabad
Cassia auriculata Roxb.	Aug-Nov.	Osmanabad
C. obtusifolia Linn.	July-Oct.	Osmanabad
C. pumila Lamk.	July-Oct.	Osmanabad
C. siamea Lamk	Sept-Dec.	Osmanabad
C. surattense Burm.	Sept-Dec.	Osmanabad
C. tora Linn.	July-Jan.	Osmanabad
Colvillea racemosa Boj.	Oct-Dec.	Aurangabad
Delonix elata (Linn.) Gamble	Aug-March	Osmanabad
Parkinsonia aculeata Linn.	Oct-Dec.	Osmanabad

Name	Flowering season	Locality
Family Mimosaceae :		
Acacia campbellii L. ..	Dec-Jan. ..	Osmanabad
A. chundra (Roxb) Willd. ..	Sept-Jan. ..	Osmanabad
A. farnesiana (Linn.) Willd.	Sept-Jan. ..	Osmanabad
A. leucophloea Willd. ..	Aug-Jan. ..	Osmanabad
A. nilotica (Linn.) Del. ..	Aug-Jan. ..	Osmanabad
A. pinnata (Willd.) ..	Oct-Jan. ..	Nanded
A. tora Craib.	July-Dec. ..	Aurangabad
Albizzia lebbek Benth ..	March-May ..	Osmanabad
A. julibrissin Derr. ..	March-May ..	Nanded
Dichrostachys cinerea W. and A.	July-Oct. ..	Osmanabad
Leucaena glauca Benth = *L. leucocarpala*. ..	Oct-Dec. ..	Osmanabad
Neptunia triquetra Benth ..	Aug-Oct. ..	Osmanabad
Mimosa hamata Willd. ..	July-Dec. ..	Osmanabad
Prosopis juliflora DC. ..	Oct-Dec. ..	Osmanabad
P. specigera Linn. ..	..	Thorny tree
Parkia biglandulosa Benth.	Dec-Feb. ..	Thorny tree
Samanea saman (Jacq.) Merr.	Feb-June ..	Thorny tree
Family Rosaceae :		
Potentilla supinum Linn. ..	March-April ..	Aurangabad
Rosa canina Linn.	July-Oct. ..	Aurangabad
R. damascena Linn. ..	July-Oct. ..	Aurangabad
Family Saxifragaceae :		
Vahlia dichotoma O. Ktze ..	Dec-Jan. ..	Osmanabad
Family Crassulaceae :		
Kalanchoe bhidei T. Cooke	Dec-Jan. ..	Aurangabad
K. diegremontiana Hand ..	Dec-Jan. ..	Aurangabad
K. pinnata (Lamk.) Pers. ..	Dec-Jan. ..	Aurangabad
Family Combretaceae :		
Anogeissus latifolia Wall. ..	Sept-Nov. ..	Osmanabad
Combretum ovalifolium Roxb.	March-April ..	Osmanabad
Terminalia arjuna W. and A.	March-April ..	Osmanabad
T. catappa Linn.	Feb-March ..	Aurangabad
Quisqualis indica Linn. ..	June-Jan. ..	Osmanabad
Calycopteris floribunda Lamk.	March	Common along forest paths.
Family Myrtaceae :		
Callistemon lanceolatus Sweet	Oct-Dec. ..	Aurangabad
Eucalyptus cladocalyx F. Muell. ..	Sept-Oct. ..	Parbhani
Psidium guyava Linn. ..	Oct-Nov. ..	Aurangabad
Syzygium cumini (Linn.) Skeels. ..	March-May ..	Osmanabad
Eugenia heyneana Wall. ..	.. ..	Common along water courses.

Name	Flowering season	Locality
Family Lythraceae :		
Ammannia baccifera Roxb.	Aug-Oct.	.. Aurangabad
A. baccifera var. *aegyptiaca* Koehna.	Aug-Jan.	.. Aurangabad
A. multiflora Roxb. ..	Sept-Nov.	.. Nanded
Lagerstroemia parviflora Roxb. ..	Feb-April	.. Aurangabad
Rotala densiflora Koehne ..	Oct-Jan.	.. Nanded
R. indica Koehne	Oct-Jan.	.. Mhaismal
R. seroyllifolia (Roth) Bram.	Dec-Feb.	.. Osmanabad
Woodfordia fruticosa Kurz. ..	Feb-April	.. Aurangabad
Family Onagraceae :		
Clarkia concinna Greene ...	Dec-Jan.	.. Parbhani
Epilobium hirsutum Linn. ..	July-Aug.	.. Parbhani
Family Samydaceae :		
Caseria tomentosa Roxb. ..	March-April	.. Aurangabad
Family Passiflaraceae :		
Passiflora edulis Sims ..	Sept-Oct.	.. Osmanabad
Family Cucurbitaceae :		
Blastania fimbristipulata (Fenz.) Kotz. and Pur. ..	Oct-Jan.	.. Aurangabad
Colocynthis vulgaris Schrad	Feb-March	.. Osmanabad
Coccinia cordifolia (Linn.) Cogn. ..	July-Dec.	.. Osmanabad
Corallocarpus epigaeus Clarke H. K. f.	Aug-Oct.	.. Osmanabad
Cucumis callosus (Rottl.) Cogen. ..	Aug-Oct.	.. Osmanabad
C. melo var. *agrestis* Haud.	Aug-Oct.	.. Osmanabad
Cucurbita moschata (Duch.) Poir.	Dec-Jan.	.. Osmanabad
Diplocyclos palmatus (Linn.) Jeffery.	Aug-Jan.	.. Osmanabad
Melothria maderaspatana Cagn. = Mukia *maderaspatana*. ..	Aug-Jan.	.. Osmanabad
Momordica dioica Roxb. ..	Aug-Oct.	.. Osmanabad
Trichosanthes anguina Linn.	Sept-Oct.	.. Osmanabad
T. cucumerina Linn. ..	Sept-Oct.	.. Osmanabad
Family Cactaceae :		
Opuntia elatior Mill ..	Sept-Oct.	.. Osmanabad
Family Aizoaceae :		
Glinus lotoides Linn. ..	Oct-Jan.	.. Osmanabad
G. oppositifolius Linn. ..	Oct-Jan.	.. Parbhani
Mollugo cerviana Ser. ..	Oct-Jan.	.. Aurangabad
M. pentaphylla Linn. ..	Sept-Oct.	.. Osmanabad
Trianthema decandra Linn. ..	June-Aug.	.. Osmanabad

Name	Flowering season	Locality
Trianthema pentandra Linn.	June—August ..	Osmanabad
T. portulacastrum Linn. ..	June—October ..	Do.
T. triquetra Linn.	June—October ..	Aurangabad
Family Apiaceae (Umbelliferae) :		
Carum copticum Hiern ..	December-Jan. ..	Osmanabad
C. stictocarpum Clarke ..	December—Feb.	Osmanabad
Foeniculum vulgare Gaertn.	November—Jan.	Osmanabad
Family Rubiaceae :		
Anotis montholonii Hook. f. = *Neanotis montholoni*	July—October ..	Osmanabad
Borreria hispida (Linn.) Schum.	July—October ..	Do.
B. stricta (Linn.) Schum. ..	July—October ..	Do.
Canthium parviflorum Benth.	May-June ..	Do.
Dentella repens Forsk. ..	July—October ..	Aurangabad
Gardenia lucida Roxb. ..	May—July	Osmanabad
Ixora arborea Roxb. ex. Sm.	July—September	Osmanabad
L. parviflora Vahl. ..		Common tree in forest.
Kohoutia aspera (Heyne ex Roth) Bremek.	March—July ..	Osmanabad
Morinda tomentosa Heyne ..	March—July ..	Do.
M. tinctoria Roxb.	March—July ..	Aurangabad
Xeromphis spinosa (Thumb.) Keay.	March—June ..	Osmanabad
Family Asteraceae (Compositae) :		
Acanthospermum hispidum DC.	September-Oct. ..	Osmanabad
Ageratum conyzoides Linn. ..	July—December	Do.
Bidens biternata (Lour.) Merr. er Sch.	July—October ..	Do.
Blumea bifoliata DC ..	December—Feb.	Osmanabad
B. lacera DC	December—Feb.	Do.
B. lacera var. *glandulosa* Hook. f.	December—Feb.	Do.
B. mollis (Don.) Merr. ..	December—Feb.	Do.
Blumea obliqua (Linn.) Druce.	December—Feb.	Osmanabad
B. oxydonta DC	December—Feb.	Do.
B. lanivillea acmella Philip.	August-September	Do.
Caesulia axillaris Roxb. ..	July—December	Do.
Callistephu chinensis Nees ..	October—Jan. ..	Aurangabad
Cosmos sulphureus Cav. ..	September—Jan.	Osmanabad
Cyathocline purpurea (Don.) O. Ktze.	December—Feb.	Do.
Dichoma tomentosa Cass. ..	October—Dec. ..	Do.
Erigeron asteroides Roxb. ..	June—October ..	Do.
E. speciosus DC	October—Dec. ..	Do.
Flaveria repanda Lagasca ..	September—Jan.	Do.
Gaillardia aristata Pers. ..	September-Oct. ..	Aurangabad
Glossocardia bosvellae DC ..	July—Oct. ..	Osmanabad
Goniocaulon glabrum Cav. ..	September—Dec.	Aurangabad
Gnaphalium indicum Linn. ..	December-Jan. ..	Mahur

Name	Flowering season	Locality
Grangea maderaspatana Poir.	October—Feb. ..	Aurangabad
Lagascea mollis Cav. ..	July—October ..	Aurangabad
Launaea nudicaulis Hook. f. = L. *procumbens*	September—Feb.	Aurangabad
Parthenium hysterphorus Linn.	June—February..	Osmanabad
Pulicaria wightiana Clarke ..	August—Oct. ..	Osmanabad
Senecio hewrensis Hook. f. ..	September—Jun.	Aurangabad
Sonchus asper Hill	July—December	Osmanabad
S. oleraceus Linn.	July—December	Osmanabad
Sphaeranthus indicus Linn. ..	September—Feb.	Osmanabad
Spilanthes paniculata Wall. ..	October—Feb. ..	Osmanabad
Tricholepis glaberrima DC ..	July—September	Osmanabad
Tricholepis radicans DC ..	July—September	Osmanabad
Tridax procumbens Linn. ..	June—December	Osmanabad
Vernonia anthelmintica Willd.	September-Oct. ..	Osmanabad
V. cinerea (Linn.) Less. ..	June—March ..	Aurangabad
Vicoa indica (Linn.) DC ..	December-Jan. ..	Aurangabad
Zinnia elegans Jacq.	September-Jan. ..	Aurangabad
Z. peruviana (Linn.) Linn. ..	September-Oct. ..	Osmanabad
Family Campanulaceae :		
Campanula alphonsii Wall. ..	December—Feb.	Aurangabad
Family Plumbaginaceae :		
Plumbago zeylanica Linn. ..	September-Oct. ..	Aurangabad
Limonium vulgare Mill. ..	June-July ..	
Family Primulaceae		
Anagallis arvensis Linn. ..	September—Feb.	Aurangabad
var. *coerulea* Godr.		
A. pumila Sw.	September—Feb.	Parbhani
Family Sapotaceae :		
Achras sapota Linn. .. = *Manilkara sapota*	January—June ..	Osmanabad
Bassia latifolia Roxb. ..	.. ..	Wild or cultivated
Madhuka indica Gmel. ..	February—April	Aurangabad
Mimusops elingi Linn. ..	February—Jan. ..	Osmanabad
M. hexandra Roxb. .. .. =*Manilkara hexandra*	.. ..	Evergreen tree
Family Ebenaceae :		
Maba nigrescens Patr. ..		
= *Diospyros nigerescens* ..	.. ..	Aurangabad
Diospyros chloroxyoln Roxb.	October-Nov.	Osmanabad
D. montana Roxb.	.. ..	Evergreen tree on dry hills.
D. candolleana Wight ..	.. ..	Aurangabad
Family Oleaceae :		
Jasminum arborescens Roxb.	March-April ..	Osmanabad
J. grandiflorum Linn. ..	Aug.—October ..	Aurangabad
J. calophyllum Wall	September-Oct. ..	Osmanabad
J. officinale Linn.	August—Oct. ..	Osmanabad

Name	Flowering season	Locality
Jasminum mesnyi Hance ..	September-Oct. ..	Parbhani
J. roxburghianum Wall. ex Hk. f.	June—Sept. ..	Osmanabad
Nyctanthes arbortristis Linn.	August—Dec. ..	Osmanabad
Schrebera swietenioides Roxb.	February—April	Aurangabad
Family Salvadoraceae :		
Salvadora persica Linn. ..	January-March ..	Aurangabad
Family Apocynaceae :		
Carissa congesta Wt. ..	March—May ..	Osmanabad
Holarrhena antidysenterica .. Wall.	March—May ..	Aurangabad
Lochnera pusilla (Linn.) Schum.	July—September	Osmanabad
Vallaris heynei Spr.	March-April ..	Aurangabad
Wrightia tinctoria R. Br. ..	April—June ..	Aurangabad
W. tomentosa Roem. ..	.. ..	Aurangabad
Family Asclepiadaccae :		
Ceropegia hirsuta W. and A.	September-Oct. ..	Aurangabad
C. tuberosa Roxb.	September-Oct. ..	Aurangabad
Cryptolcpis buchanannii R. and S.	August—October	Osmanabad
Dregea volubilis Benth. ..	January—March	Aurangabad
Gymnema sylvestre R. Br. ..	October-Jan. ..	Osmanabad
Calatropis gigantea Brald. ..	.. ..	Common along villages and waste lands.
C. procera Br.		
Hemidesmus indicus Hk. f. R. Br. var. *rubescens*	September-Oct. ..	Osmanabad
Holostema annulare (Roxb.) Schum.	August—Oct. ..	Osmanabad
Sarcostemma brevistingna R. Br.	February—April	Aurangabad
S. secamone (Linn.) Bennett.	July—September	Parbhani
Stapelia gigantea N. E. Br. ..	September-Oct. ..	Aurangabad.
Telosma pallida (W. and A.) Craib.	September-Oct. ..	Osmanabad
Tylophora indica (Burm. f.) Merr.	September-Oct. ..	Osmanabad
Tylophora rotundifolia Ham.	June—September	Aurangabad
Pergularia pallida Awand A.	.. ..	Common in hedges in scrub jungles.
Family Loganiaceae :		
Strychnos potatorum Linn. F.	September-Oct. ..	Osmanabad
S. nux-vomica Linn.	.. ..	Common in forest.
Family Gentianaceac :		
Canscora decurrens Dalz. ..	December—Feb.	Osmanabad
C. pauciflora Dalz.	November—Feb.	Osmanabad
Centaurium roxburghii (Don.) Druce.	October—Jan. ..	Osmanabad

Name	Flowering season	Locality
Enicostema littorale Bl. ..	June—January ..	Aurangabad
Exacum pedunculatum Linn.	September—Nov.	Osmanabad
Hoppea fastigiata Clarke ..	September—Nov.	Osmanabad
Nymphoides cristatum (Roxb.) O. Kuntze.	December—Feb.	Nanded
Family Polemoniaceae :		
Phlox drummondii Hook. ..	October—Jan. ..	Aurangabad
Family Boraginaceae :		
Carmona retusa (Vahl.) .. Masam.	August-September	Aurangabad
Cordia dichotoma Forst. f. ..	April—June ..	Aurangabad
C. mixa Linn.		
Cordia gharaf (Forsk.) Ehrenb. and Sch.	April—June ..	Osmanabad
C. macleodii Hk. f. and T. .. and T.	March—May ..	Aurangabad
C. sebestina Linn.	February—May..	Aurangabad
Cynoglossum meeboldii Brand.	August—October	Aurangabad
Ehretia laevis Roxb. ..	March—May ..	Aurangabad
Heliotropium ovalifolium .. Forsk.	October—Feb. ..	Osmanabad
H. rariflorum Stocks ..	August—October	Aurangabad
H. scarum Retz. .. var. *wallichii* Clarke	September—Jan.	Osmanabad
H. supinum Linn.	October—Jan. ..	Osmanabad
Trichodesma amplexicaula Roth.	September-Oct. ..	Osmanabad
Trichodesma indicum R. Br...	July—Jan. ..	Osmanabad
Rhabdia lycicoides Mart. .. = *Rotula aquatica*	.. ..	Common in rocks in large river beds.
Family Convolvulaceae :		
Convolvulus arvensis Linn. ..	October—Jan. ..	Osmanabad
C. rottlerianus Choisy ..	January-Feb. ..	Aurangabad
Evolvulus alsinoides Linn. ..	July—February ..	Aurangabad
Hewittia sublobata (Linn. f.) O. Kuntze.	October-Nov. ..	Osmanabad
Ipomoea carrica Sweet ..	October—Feb. ..	Osmanabad
I. fistulosa Mart. ex. Choisy	October—Feb. ..	Nanded
I. eriocarpa R. Br.	October—Feb. ..	Osmanabad
I. hederifolia Linn.	October—Dec. ..	Osmanabad
I. horsfaliae Hook.	October—Feb. ..	Osmanabad.
I. leari Paxt.	October—Feb. ..	Aurangabad
I. muricata Jacq.	October—Feb. ..	Osmanabad
I. nil (Linn.) Roth	October—Feb. ..	Osmanabad
I. obscura Ker-Gawl ..	October Feb. ..	Osmanabad
I. pestigridis Linn.	October—Feb. ..	Aurangabad
I. purpurea Lam.	October—Feb. ..	Aurangabad
I. quamoclit Linn.	September—Feb.	Osmanabad
Merremia aegyptia (Linn.) Urban.	October—Feb. ..	Osmanabad
M. emarginata Hall. f. ..	October—Feb. ..	Osmanabad

Name	Flowering season	Locality
M. quinquefolia (Linn.) Hall. f.	October—Feb. ..	Osmanabad
Porana paniculata Roxb. ..	October—Feb. ..	Aurangabad
Rivea hypocrateriformis .. Choisy.	September—Jan.	Osmanabad
Rivea ornata Choisy ..		
Family Solanaceae :		
Datura metel Linn.	July—October ..	Osmanabad town
Nicandra physaloides (Linn.) Gaertn.	September—Nov.	Mhaismal
Nicotiana glauca Grah. ..	December—Mar.	Aurangabad
N. repanda Lehm.	September-Oct. ..	Aurangabad
Physalis minima Linn. ..	September-Oct. ..	Osmanabad
Petunia hybrida Ulm ..	January—March	Aurangabad
Solanum incanam Linn. ..	June—September	Osmanabad
S. indicum Linn.	September—Nov.	Osmanabad
S. nigrum Linn.	September-Oct. ..	Osmanabad
S. sisymbrifolium Lam. ..	July—September	Osmanabad
S. verbascifolium Linn. ..	September—Jan.	Osmanabad
Withania somnifera Dunn. ..	September—Jan.	Osmanabad
Family Scrophulariaceae :		
Antirrhinum majus Linn. ..	September—March	Aurangabad
Dopatrium junceum Buch-Ham.	September—Jan.	Osmanabad
Limnophila racemosa Benth.	October-Nov. ..	Aurangabad
Lindenbergia urticifolia Lehm.	August—Oct. ..	Aurangabad
Mimulus gracilis R. Br. ..	August-September	Aurangabad
Russelia rotundifolia Cav. ..	December—Jan.	Aurangabad
Sopubia delphinifolia Don ..	September-Oct.	Osmanabad
Stemodia viscosa Roxb. ..	November—Jan.	Osmanabad
Striga angustifolia (Don.) Sald.	August—Jan. ..	Aurangabad
S. gesneroides (Willd.) Vatke.	October—Jan. ..	Aurangabad
Sutera dissecta (Del.) Walp.	November—Feb.	Osmanabad
Verbascum chinense Sant. ..	September—Feb.	Osmanabad
Veronica anagallis-aquatica Linn.	September-Oct. ..	Osmanabad
Family Orobanchaceae :		
Orobanche cernua Loef. var. nepalensis DC.	September-Oct. ..	Osmanabad
Family Lentibulariaceae :		
Utricularia caerulea Linn. ..	September-Oct. ..	Osmanabad
U. stellaris Linn. f. ..	December-Jan. ..	Parbhani
Family Bignoniaceae :		
Dolichandrone falcata Seem.	December—Mar.	Osmanabad
Doxantha angiscati Rehdr. ..	December-Jan.	Aurangabad
Heterophragma roxburghii DC	December—Mar.	Aurangabad
Millingtonia hortensis Linn. f.	June—September	Aurangabad
Teconia stans (Linn.) Seem. ..	August—Oct. ..	Osmanabad
Tecomalia capensis Spach ..	January—March	Aurangabad

Name	Flowering season	Locality
Family Pedaliaceae :		
Martynia annua Linn. ..	August—Oct. ..	Osmanabad town
Sesamum -indicum Linn. ..	September-Oct. ..	Osmanabad
Family Acanthaceae :		
Andrographis echioides Nees	September-Oct. ..	Osmanabad
A. paniculata Nees	September-Oct. ..	Mahur
Asystasia lawiana Dalz. ..	September-Oct. ..	Aurangabad
Barleria cristata Linn. ..	September-Oct. ..	Osmanabad town
B. prionitis Linn.	September-Oct. ..	Osmanabad town
Blepharis asperrima Nees ..	August—Oct. ..	Aurangabad
B. molluginifolia Pers. ..	Oct.—Jan. ..	Mahur
Calliaspidia guttata (Brend.) Brem.	December—Feb.	Parbhani
Decliptera micranthes Nees ..	December-Jan. ..	Mahur
Dipteracanthus patulus Nees	July—December	Osmanabad
Dipteracanthus prostratus (Poir) Nees.	July—December	Osmanabad
Dyschoriste erecta (Burm.) O. Kuntze.	October—Jan. ..	Aurangabad
Franthemum purpurascens Nees.	October—Jan. ..	Mahur
Haplanthus verticillaris (Roxb.) Nees.	October—Jan. ..	Mahur
Hemigraphis dura T. Anders	December—Feb.	Osmanabad
H. latebrosa Nees .. var *Meyneana* Brem.	December—Feb.	Osmanabad
Hygrophila obovata (Roxb.) Nees.	December—Jan.	Osmanabad
H. auriculata (Schum.) Hains	September—Feb.	Osmanabad
Justicia betonica Linn. ..	October—Jan. ..	Osmanabad
J. diffusa Willd.	August—Nov. ..	Osmanabad
J. gendarrusa Linn. ..	August—Jan. ..	Aurangabad
J. orbiculata Wall.	August—Nov. ..	Aurangabad
J. prostrata Gamble	August—Nov. ..	Osmanabad
J. quinangularis Koen. ..	August—Nov. ..	Aurangabad
J. vahlii Clarke	August—Feb. ..	Aurangabad
Lepidagathissubarmata Gamble.	August—Dec. ..	Osmanabad
Phaulopsis densiflora (Retz.) Sant.	November—Jan.	Parbhani
Rungia parviflora Nees ..	September-Jan. ..	Mahur
R. repens Nees	July—Dec. ..	Osmanabad
Thumbergia laevis Nees ..	August-Sept. ..	Osmanabad
Strobilanthes callosus Nees .. *Carria callosa*	..	Ajantha hills, Aurangabad
Family Verbenaceae :		
Citharexyion subserratum Sw.	August—Oct. ..	Aurangabad
Clerodendrum phlomides Linn.	January-Feb. ..	Osmanabad
Duranta erecta Linn. ..	October—Dec. ..	Aurangabad
Holmskioldia sanguinea Retz.	October—Dec. ..	Aurangabad
Phyla nodiflora (Linn.) ..	June—March ..	Osmanabad
Priva cordifolia (Linn. f.) Druce	October—Feb. ..	Aurangabad
Tectona grandis Linn. f. ..	September—Dec.	Osmanabad

Name	Flowering season	Locality
Stachytarphetajamaicensis (Linn.) Vahl. ..	December—Mar.	Aurangabad
Verbena bipinnatifida Nutt ..	January-Feb. ..	Aurangabad
V. officinalis Linn. ..	February-March	Osmanabad
Vitex negundo Linn. ..	September—Jan.	Osmanabad
Family Lamiaceae (Labiatae) :		
Anisomeles indica (Linn.) O. Rtze.	September—Nov.	Osmanabad
Coleus barbatus Benth. ..	August—Oct. ..	Aurangabad
Colebrookia oppositifolia Smith.		Dry hills
Geniosporum tenuiflorum (Linn) Merr.	September—Jan.	Osmanabad
Hyptis suaveolens Poit. ..	September—Jan.	Osmanabad
Lavendula bipinnata (Linn.) O. Kuntze.	October—Jan. ..	Osmanabad
Leonotis nepetifolia R. Br. ..	October—Jan. ..	Osmanabad
Leucas aspera Spr. ..	August—Oct. ..	Osmanabad
L. biflora R. Br. ..	August—Oct. ..	Osmanabad
L. cephalotes Spreng. ..	August—Oct. ..	Osmanabad
L. stricta Benth. ..	August—Oct. ..	Aurangabad
L. urticifolia R. Br. ..	August—Oct. ..	Aurangabad
Majorana hortensis Moench.	August—Oct. ..	Aurangabad
Meriandra bengalensis Benth.	December-Jan. ..	Aurangabad
Ocimum gratissumum Linn.	September-Oct. ..	Osmanabad
Salvia plebeia R. Br. ..	December-Jan. ..	Osmanabad
Salvia splendens Bello. ..	December-Jan. ..	Aurangabad
Family Plantaginaceae :		
Plantago exigua Murr. ..	August-Sept. ..	Aurangabad tow
Family Amaranthaceae :		
Achyranthes aspera Linn. var. *porphyristachya* Hook. f.	July—December	Aurangabad
Alternanthera pungens H. Bk.	June—February	Osmanabad
A. sessilies (*Linn.*) R. Br. ..	August—Oct. ..	Osmanabad
A. versicolor Regl. ..	August—Oct. ..	Aurangabad
Amaranthus caturus Heyne.	August—Oct. ..	Osmanabad
A. dubius Mart. ex. Thell ..	August—Oct. ..	Osmanabad
Amaranthus hybricu;Linn.SS cruentus thell var paniculatus	January—March.	Osmanabad town
A. lividus Linn. ssp. ..	August—Oct. ..	Osmanabad town
A. polygonoides ..	July—October ..	Osmanabad town
A. spinosus Linn. ..	July—September	Osmanabad town
A. tricolor Linn. ..	Aug—Oct. ..	Osmanabad
A. viridis Linn. ..	July—February ..	Osmanabad
Cleosia argentea Linn. ..	August—Feb. ..	Osmanabad
Digera muricata Mart. ..	August—Dec. ..	Osmanabad town
Gomphrena celosioides Mart.	August—Feb. ..	Aurangabad
G. globosa Linn. ..	August—Oct. ..	Aurangabad
Pupalia leppacea Mig. ..	September—Oct.	Osmanabad
Family Caryophyllaceae :		
Polycarpaea Corymbosa Lam.	September—Dec.	Osmanabad

Name	Flowering season	Locality
Family Chenopodiaceae :		
Atriplex hortiensis Linn. ..	August—Oct. ..	Aurangabad
Basella rubra Linn. ..	December—Feb.	Aurangabad
Chenopodium album Linn. ..	August—Dec. ..	Aurangabad
C. murale Linn. ..	December—Feb.	Osmanabad
Spinacia oleracea Linn. ..	December—Feb.	Aurangabad
Family Lauraceae :		
Litsea polyantha Juss. ..	.. ..	Aurangabad
Cassytha filiformis Linn. ..	.. ..	Parasite on common hedge plant.
Family Polygonaceae :		
Homalocladium platycladum Bailey.	December-Jan. ..	Aurangabad
Polygonum flaccidum Messm.	October—Feb. ..	Nanded
P. glabrum Willd. ..	August—Oct. ..	Osmanabad
P. plebejum R. Br. ..	December—Feb.	Osmanabad
P. tomentosum Willd. ..	September-Oct. ..	Aurangabad
Rumex dentatus Linn. ..	November—Jan.	Osmanabad
R. vesicarius Linn. ..	January-Feb. ..	Aurangabad
Family Aristolochiaceae :		
Aristolochia bracteata Retz..	August—Oct. ..	Aurangabad
A. indica Linn. ..	August—Oct. ..	Osmanabad
Family Loranthaceae :		
Viscum articulatum Burm. ..	February—April	Aurangabad
Dendraphthoe falcata Etting.	February—April	Aurangabad
Family Santalaceae :		
Santalum album Linn. ..	February—April	Aurangabad
Family Euphorbiaceae :		
Acalypha ciliata Forsk. ..	August-September	Osmanabad
A. hispida Muell. Arg. ..	June—April ..	Aurangabad
A. indica Linn. ..	June—January ..	Osmanabad
A. lanceolata Willd. ..	July—January ..	Osmanabad
Baliospermum montanum Bl.	September-Oct. ..	Osmanabad
Breynia nivesa Spreng. ..	.. ..	Common in dry hills.
Chrozophora prostrata Dalz.	January-Feb. ..	Osmanabad
Givotia rottleyriformis Griff.	Hot season ..	Marathwada
Emblica officinalis Gaertn. ..	September-Oct. ..	Marathwada
E. phorbia coccinea Roth ..	October—January	Aurangabad
E. corrigioloides Boiss. ..	July—October ..	Osmanabad
E. cristata Heyoe ..	October—Jan. ..	Osmanabad
E. dracunculoides Lamk. ..	January—June ..	Osmanabad
E. elegans Spr. ..	September– Jan.	Osmanabad
E. fimbriata Heyne ..	September—Oct.	Osmaflabad
E. orbiculata Mig. ..	December—Feb.	Osmanabad
E. prostrata Avt. ..	August—Jan. ..	Osmanabad
E. rothiana Spreng. ...	July—October ..	Aurangabad
E. thymifolia Linn. ..	June—January ..	Osmanabnd

Name	Flowering season	Locality
E.zornioides Boiss. ..	August—Oct. ..	Aurangabad
Jatropha gossypifolia Linn.	Nov-Feb. ..	Osmanabad
J. curcas Linn. ..	Nov-Feb. ..	Osmanabad
Phyllanthus fraternus Webs.	Sept-Dec. ..	Aurangabad
P. maderas Patanai ..	Sept-Feb. ..	Aurangabad
P. emblica Linn. ..	..	Sparse in forest
Mallotus philippinensis Muell	..	..
Sapium insigne Benth. ..	Jan-April ..	Aurangabad
Securinega leucopyrus Muell	Dec-Feb. ..	Aurangabad
S. virosa Pax and Hoffm. ..	Sept-Jan. ..	Aurangabad
Tragia cannabina Linn. f. ..	Dec-Feb. ..	Osmanabad
T. montana Muell-Arg. ..	Dec-Feb. ..	Parbhani
Family Urticaceae :		
Fleurya interrupta (Linn.) Gaud. ..	Aug-Oct. ..	Aurangabad
Ficus tsiela Roxb ..	Cultivated ..	Aurangabad
Girardinia zeylanica Dene.	Oct-Dec. ..	Aurangabad
Holoptelia integrifolia Planch.	March-April ..	Aurangabad
Streblus asper Lour.	..	Common on dıy hills and river-sides.
Family Casuarinaceae :		
Casuarina equisetifolia Linn.	Jan-March ..	Aurangabad
Family Salicaceae :		
Salix tetrasperma Roxb. ..	March-May ..	Aurangabad
Family Ceratophyllaceae		
Cerotophyllum demersum Linn. ..	Oct-March ..	Aurangabad
Family Hydrocharitaceae :		
Nechamandra alternifolia (Roxb.) Thro. ..	Jan-March ..	Parbhani
Ottelia alismoides (Linn.) Pers. ..	Jan-Feb. ..	Nanded
Family Orchidaceae :		
Eulophia ramentacea Lindl.	Dec-Jan. ..	Aurangabad
Habenaria marginata Coleb.	Sept-Oct. ..	Osmanabad
H. platyphylla Spreng. ..	Sept-Oct. ..	Osmanabad
Zeuxine strateumatica Schlect.	Dec-Feb. ..	Aurangabad
Family Amaryllidaceae :		
Curculigo orchioides Gaertn.	Sept-Oct. ..	Aurangabad
Eurycles sylvestris Salisb. ..	March-April ..	Aurangabad
Furcarea gigantea Vent. ..	Sept. ..	Aurangabad
Family Dioscoreaceae :		
Dioscorea alata Linn. ..	Aug-Oct. ..	Aurangabad
D. bulbifera Linn. ..	Sept-Oct. ..	Aurangabad
D. hispida Dennst. ..	Sept-Oct. ..	Aurangabad

Name		Flowering season		Locality
Family Liliaceae :				
Asparagus racemosus Willd var. *javanicus* Baker.		July-Oct.	..	Osmanabad
Chlorophytum bharuchae Ans. Ragh. et. Hem.		June-Aug.	..	Aurangabad
C. capense O. Kuntze	..	Sept-Jan.	..	Aurangabad
C. laxum R. Br.	..	June-Aug.	..	Aurangabad
C. tuberosum Baker	..	June-Aug.	..	Aurangabad
Dipcadi montanum Baker	..	June-July	..	Aurangabad
Gloriosa superba Linn.	..	Sept-Oct.	..	Aurangabad
Iphigenia indica Kunth	..	July-Aug.	..	Aurangabad
I. pallida Baker ..	..	July-Aug.	..	Aurangabad
Urginea coromendeliana Hook. f.		March-April	..	Aurangabad
Aloe vera Linn.	..	..		Aurangabad
Family Pontedariaceae :				
Monochoria vaginalis Preses		Sept.	..	Nanded
Family Commelinaceae :				
Amischophacelus axillaris (Schultz) Rao.		Sept.	..	Nanded
A. cucullata (Kunth) Rao	..	Sept-Oct.	..	Osmanabad
Commelina bengalensis Linn.		Sept-Oct.	..	Aurangabad
C. nudiflora Linn. = *Murdania nudiflora.*	..	Sept-Oct.	..	Osmanabad
C. kurzii Clarke	..	Sept-Oct.	..	Aurangabad
Cyanotis cristata Schult.	..	Sept-Oct.	..	Osmanabad
C. fasciculata Schult.	..	Sept-Oct.	..	Aurangabad
C. tuberosa var. *adseodens* Cl.		July-Aug.	..	Osmanabad
Family Typhaceae :				
Typha angustata Aub. Bory		..		Aurangabad
Family Palmae :				
Phoenix sylvestris Roxb.	..	Jan-March	..	Osmanabad
Family Araceae :				
Amorphophallus sylvaticus Kunth.		May-June	..	Aurangabad
Cryptocorcne retrospiralis Kunth.		Dec.-Feb.	..	Aurangabad
Family Alismaceae :				
Lemna paucicostata Hagel	..	Oct-March	..	Osmanabad
Wolffio arrhiza Wimm.	..	Sept-March	..	Osmanabad
Family Alismaceae :				
Limnophyton obtusifolium (Linn.) Mig.		Dec-Feb.	..	Nanded

Name	Flowering season	Locality
Family Naiadaceae :		
Aponogeton natans (Linn.) Engl. et. Krausel.	Jan.	Nanded
Najas graminea Del.	Sept-March	Osmanabad
Potamogeton nodosus Poir.	Oct-Feb.	Nanded
P. pectinatus Linn.	Oct-Jan.	Parbhani
Zannichellia palustris Linn. ssp *pedicellata.*	Sept-Oct.	Aurangabad
Family Eriocaulaceae :		
Eriocaulon lun ulaefolium Mart.	Sept-Oct.	Aurangabad
Family Cyperaceae :		
Bulbostylis barbata Kunth	Aug-Oct.	Osmanabad
Cyperus alopecuroides Roth.	Sept-Oct.	Osmanabad
C. aristatus Roth	Sept-Oct.	Osman abad
C. compressus Linn.	Sept-Oct.	Aurangabad
C. corymbosus Roth.	Sept-Oct.	Osmanabad
C. difformis Linn.	Aug-Oct.	Osmanabad
C. elusinoides Kunth	Sept-Oct.	Osmanabad
C. esculentus Linn.	Sept-Oct.	Osmanabad
C. exaltatus Retz.	Sept-Oct.	Osmanabad
C. globosus All.	Sept-Oct.	Aurangabad
C. hyalinus Vahl.	Sept-Oct.	Nanded dist.
C. pangorei Roth.	Sept-Oct.	Osmanabad
C. pumilus Linn.	Sept-Oct.	Osmanabad
C. rectangularis (Kuk.) Benn.	Sept-Oct.	Osmanabad
C. rotundus Linn.	Sept-Oct.	Osmanabad
C. teneriffae Poir	Sept-Oct.	Osmanabad
Eleocharis plantaginea R. Br.	Sept-Oct.	Aurangabad
Eriophorum comosum Wall	Oct-Jan.	Aurangabad
Fimbristylis complanata Link.	Sept-Oct.	Osmanabad
F. diphylla Vahl.	Sept-Oct.	Osmanabad
F. dichotoma Vahl.	Sept-Oct.	Aurangabad
F. ferruginea Vahl.	Sept-Oct.	Aurangabad
F. junciformis Vahl.	Sept-Oct.	Osmanabad
F. monostachya Hessk.	Sept-Oct.	Osmanabad
F. schonoides Vahl.	Sept-Oct.	Osmanabad
F. tetragona R. Br.	Sept-Oct.	Osmanabad
Fuirena walichiana Kunth.	July-Oct.	Osmanabad
Kyllinga triceps Roth.	July-Jan.	Osmanabad
Scirpus corymbosus Heyne ex Roth.	Sept-Oct.	Aurangabad
S. squarrosus Linn.	Sept-Oct.	Osmanabad

6. LIST OF PLANTS FROM AJANTHA HILLS

Ajantha are low trap hills with the world famous caves having sculpture and paintings. Their features and expressions are exquisite and are famous world over especially the roof and wa l coloured paintings and the scenes from the life of Buddha.

Family Violaceae
Viola tricolour Linn.

Cochlospermoceae
Cochlospermum gossipium DC.

Polygalaceae
Polygala fullothrix Dunn.

Elatinaceae
Bergia ammanoides Heyne.

Malvaceae:
Sida rhomboidifolia L.

Sterculiaceae
Helicteris isora L.

Oxalidaceae
Biophytum sensitivinum (*L.*) DC.

Tropaeolaceae
Tropaeolum sp.

Simarubuceae
Ailanthus excelsa Roxb.

Burseraceae
Boswellia serrata Roxb.

Meliaceae
Azadiracta indica A. Juss.

Rhamnaceae
Zizyphus globerrima Sant.
Z. xylopyra Willd.

Ampelidaceae
Leea indica (Burm.) Merrill.

Anacardiaceae
Lannea grandis (Hoult) Merrill.

Fabaceae Papilionaceae
Crotalaria filiceps Benth.
C. medicagirea Lamk.
Psoralea corylyfolia L.
Mucuna prurita Hook.
Dalbergia latifolia Roxb.

Caesalpinaceae
Hardwickia binata Roxb.

Mimosae
Mimosa hamata Willd.
Acacia ferruginea DC.
A. tomentosa Willd.

Combretaceae
Terminalia chebula Retz.
T. arjuna Wight.
Anogeissus latifolia Wall.

Onagraceae
Ludwigia parviflora Roxb.

Rubiaceae
Anotis lancifolia (Dalz.) Hook.

Compositeae
Vicova tomentosa Can.

Oleaceae
Nyctanthes arbor-tristis Linn.

Apocynaceae
Wightia tinctoria Br.
W. tomentosa Roem and Schultez.

Convolvulaceae
Argyreia cunneata Ker Gawl.

Solanaceae
Physalis minima L.

Scrophulariaceae
Buchnera hispida Buch. Ham.
Sopubia delphinifolia (Roxb.) G. Den.

Bignoniaceae
Dolichondron falcata Seem.

Verbenaceae
Vitex negundo L.

Labiatae
Lavendula burmanii Benth.

Euphorbiaceae
Euphorbia rothiana Spr.
Bridelia retusa Spr,

Hypoxydaceae
Hypoxis aurea Lour.
Curculigo orchioides Gaertn.

Amaryllidaceae
Crinum asiaticum L.

Dioscoreaceae
Dioscorea oppositifolia
D. triphylla.

Commelinaceae
Cyanotis tuberose (Roxb.) Schultez.

Gramineae
Cymbopogon nardus (L.) Rend.

7. Plants of Kannad Ghat and Region Around

Family Ranunculaceae
Clematis gouriana Roxb. ex DC.
C. wightiana Wall.

Menispermaceae
Tinospora cordifolia (Willd.) Miers

Capparidaceae
Capparis horrida Linn.
C. spinosa L.

Flacourtiaceae
Flacourtia montana Graham.

Cochlospermaceae
Cochlospermum gossypium DC.

Caryophyllaceae
Polycarpea corymbosa (Linn.) Lamk.

Elatinaceae
Bergia ammanioides Heyne ex Rath.

Malvaceae
Hibiscus micranthus L.
Kydia calycina.
Thespesia lampas Dalz and Gibs.

Tiliaceae
Triumfetta pillosa Rath.

Malpighiaceae
Hiptage benghalensis (Linn.) Kurz.

Balsaminaceae
Impatiens sp.

Meliaceae
Cippadesa baccifera (Roth) Mia.
Azadiracta indica Jassu.
Melia axadirecta L.
Heynea triguga Roxb.
Suietenia mohagonii Linn.

Rhamnaceae
Zizyphus rugosa Lamk.
Zizyphus glaberrima Sant.
Z. xylopcarpa Willd.
Z. oenoplea Mill.
Ventilago madraspatana Gaertn. .. June-Sept.

Ampelidaceae
Leea indica (Burm.) Merrill.
L. sambucina Willd.

Anacardiaceae
Buchanania lanzan Spreng .. Dec-Jan.
Mangifera indica L.

Fabaceae (Papilionaceae)
Crotolaria medicaginea Lamk.
Smithia sensitiva Ait.
Desmodium triquetrum (L.) DC.
D. rotundifolium Baker.
Mucuna prurita Hook.
Dalbergia latifolia Roxb. .. Au. -Oct.
Uraria alopecuroides Wt.

Caesalpiniaceae
Wagatea spicata Dalz.
Bauhinia racemosa Lamk.
B. vahlli W. and A.
Hardwickia binnata Roxb.

Mimosae
Acacia feruginea DC.
A. tomentosa Willd.

Combretaceae
Terminalia bellerica (Gaertn.) Roxb.
T. chebula Retz.
T. arjuna Wight.
T. tomentosa Willd.
Anogeissus latifolia Walli.
Enocarpus latifolia Roxb.
Calycopteris floribunda (Roxb.) Damk.

Melastromaceae
Melastoma malbaricum Linn.
Osbeckia truncata Don.
= *O. zeylanica* Graham.

Lythraceae
Ammania rotundifolia Buch Ham.
Rotalia rotundifolia Buch. Ham.

Onagraceae
Jussiaea suffruticosa Linn.
J. repens Linn.
Ludwigia parviflora Roxb.

Passifloraceae
Passiflora foetida Linn.

Cucurbitaceae
Trichasanthes bracteata (Lamk.) Wight.
Melothria heterophylla Linn.
M. triphylla Linn.

Umbelliferae
Pimpinella laterifolia Dalz et Cubbs.

Rubiaceae
Ixora arborea Roxb.
I. parviflora Vahl.
Vangurea spinosa Roxb.

Compositeae (Lamiaceae)
Blumea virens DC.

Primulaceae
Anagalis arvensis Linn. var. *caerculea* Gren and Codr.

Ebenaceae
Maba nigricans Roxb.

Oleaceae
Jasminum malabricum Wight.
=*J. latifolium* Graham.
Olea dioica Roxb.

Apocynaceae
Wrightia tomentosa Roem and Schultz.
Alstonia scholaris (Linn.) R. Br.
=*Echites scholaris* Linn.

Asclepiadaceae
Hemidesmus indicus (Linn.) R. Br.
Hoya wightii Hook.
=*Hoya pallida* Dalz.

Gentianaceae
Exacum pumilum Griseb.
E. bicolor Roxb.
Fimanthrum indicum (Linn.) Griseb.
Swertia minor (Griesb.) Knabl.

Hydrophyllaceae
Hydrolea zeylanica (Linn.) Vahl.

Boraginaceae
Paracarium malabiricum Clarke.

Solanaceae
Physalis minima Linn.

Scrophulariaceae
Dopatrimum juncum (Roxb.) Buch. Ham.
Buchnera hispida Buch-Ham.
Sopubia delphinifolia (Roxb.) G. Doz.

Lentibulariaceae
Utricularia reliculata Smith.
U. graminifolia.

Bignoniaceae
Dolichondron falcata.
=*D. laurii* Graham.
Heterophragma chelonoides DC.
Sterospermum personatum (Hossk) Chatterjee.

Acanthaceae
Andrographis echinoides Nees.
Justicia simplex D. Don.

Verbanaceae
Callicarpa tomentosa (Linn.) Murray.

Labiateae
Lavendula burmanii Benth.
Orthosiphon tomentosum
=*O. glabratus* Benth.

O. rubicundus.
Pogostemon parviflorus Benth.
Leucas ciliata Benth.

Loranthaceae
Dendrophthoe falcata (Linn.) *Etting*
= *Loranthus longiflorus*
Desv.
Viscum nepalense Spreng.
V. *articulatum* Hook.
= *V. attennuatum* DC.

Santalaceae
Byris wightiana Wall.
= *O. arborea* Wall.

Euphorbiaceae
Euphorbia rothiana Spr.
Bridelia retusa (Linn.) Spreng.
Glochidion hoheniackeri Redd.
=*Bridelia sinica* Graham.
Mallotus aures-punctatus
(Dalz.)
Crivotia rettlemiformis Griff.
Coenocephalus niveus Wight.
= *Boehmeria romiflora* Gr.
Capsi.

Moraceae
Ficus hispida Linn.
Cavellia oppositifolia Gasp.
= *Ficus appositifolia* Willd.

Salicaceae
Salix tetrasperma Roxb.

Hydrocharitaceae
Vallisneria spiralis Linn.

Orchidaceae
Eulophia nuda Lindl.
Habenaria rariflora Lindl.
H. marginata Caleb.

Zinziberaceae
Curcuma amada Roxb. .. June-July.
C. rubescens Roxb. .. June-July.

Amaryllidaceae
Crinum moorei Hook f. .. March-April.

Gramineae
Bambusa arundiana Retz.
B. arundinaceae Klein.
B. stricta Lodd.
Sporobolus diander Beauve
S. indicus (Linn.) R. Br.
Apluda aristata Linn.
=*A. varia* Hook.
Eragrostis latifolia Wight.
E. viscosa Trim.
E. tenella R. and S.

8. Plants of Kinwat

Name	Flowering Season
Family Olacaceae :	
Olax scandens Roxb.	July—February
Ampelidaceae :	
Cissus woodrowii Sant. =*Vitis woodrowii* Stapf.	June—September
Caesalpinaleae :	
Bauhinia lanzan Spreng.	December-January
Alysicarpus lamosus Edgens	September-October
Crotolaria sericea Retz.	November—February
Dalbergia paniculata Roxb.	June-July
Roynchosia capitata DC	September-October
Uraria alopecurodes Wt.	August—October
U. hamosa Wall.	August—October
Combretaceae :	
Terminalia paniculata L.	February-March
Lythraceae :	
Rotalia mexicana Chain	September-October
Cucurbitaceae :	
Melothria laterophylla Cong.	September-October
Umbelliferae :	
Pimpinella latifolia Dalz et Gibbs.	September-October
Rubiaceae :	
Adina cordifolia Benth. and Hook. f.	September-October
Gardenia latifolia Ait	May-June
Hamiltonia suaveolens Roxb.	October-January
Knoxia corymbosa Willd.	September-October
Oldenlandia offinis DC	September-October
Campanulaceae :	
Labelia heyneana R. and S.	September—January
Ebenaceae :	
Diospyros tomentosa Roxb.	July-August
Loganiaceae :	
Hitreola oldenlandioides Wall.	September-October
Gentianaceae :	
Canscora decuminata R. and S.	September—November

Name	Flowering Season
Convolvulaceae :	
Lettsomia setosa Roxb.	August—January
Copercalina turpethum (Linn.) Manso	October—February
Rivea ornata Choisy	September—January
Solanaceae :	
Lindernia ciliata (Colsm.) Perin	September-October
L. crustacea (L.) Muell	September-October
Acanthaceae :	
Barleria montana Nees	August—October
Labiatae :	
Orthosiphon rubicundus	July—October
Ocimum americanum	September-October
Euphorbiaceae.	
Euphorbia pincnostegia Boiss. var. *Laxa* Boiss.	September—January
Phyllanthus simplex Don.	
P. arinaria Linn.	August—December
Urticaceae :	
Trema orientalis Planch.	April-May
Orchidaceae :	
Vanda tesellata Hook.	April—June
Zingiberaceae :	
Curcuma amanda Roxb.	June-July
C. rubescens Roxb.	June-July
Amaryllidaceae :	
Crinum moorei Hook.	March-April
Araceae :	
Typhonium trilobetum Schott.	June-July
Sagittaria guayenensia (D. Don) Buchen	September-October
Alismoceae :	
Tenagocharis latifolia (Den.) Duchen	September-October
Cyperaceae :	
Fimbristylis quinqueangularis Kunth	September-October

NOTE :—References to the Flora of Marathwada are given on page No. 367.

SECTION B—FLORA OF KHANDESH

CONTENTS

SECTION B—FLORA OF KHANDESH

1. Geographic situation of Khandesh

Khandesh comprises two districts of Dhule or West Khandesh and Jalgaon or East Khandesh. It lies in the valley of Tapi and is separated from Western Maharashtra by the hills of Laling and Silbari and their extensions. It lies above the mean level at an altitude of about 700 meteres. Ajantha hills are to its South. Satpuda ranges cross it parallel from east to west. It is adjacent to Nasik, Aurangabad and Buldhana districts. The valley of Khandesh is broad. It is plain and rises gently towards west, there being mountains on its both sides, Ajantha and Satpudas. The hills are mostly formed by the Deccan traps and so are the soils. The monsoons are long, continuing from June. They last till October. The hill sides are covered with dense vegetation, but the country between Satpuda ranges is plain.

The flora of Khandesh with special reference to Satpudas has been worked out by Mahabale and Karnik (1959) and Karnik (1955, 1956). The list of species collected by them is given here. It will be seen from this list that there are very few moist humid species. They are mostly dry deciduous or scrubby plants. This is because the climate of Khandesh suffers from extremes. Rains are confined to rainy season, winter very cold and summer very hot. Soils are alluvial on the banks of rivers and black cotton soils elsewhere. Once the Tapi is crossed the black cotton soils appear again. They are deep, sticky, often calcarious. Analysis of typical soil samples in Khandesh is given in Analysis of Soils in Khandesh.

General topography of Khandesh is partly plain and partly wavy due to Satpudas. Authors like Dalzell and Gibson (1861), Talbot (1906), Hooker (1904), Blatter and McCann (1935) have made passing references to the plants of Khandesh, but there had been no comprehensive account of them. Cooke (1904—1908) describes only a few plants from Khandesh in the *Flora of the Bombay Presidency*. It is obvious that many places in Khandesh need to be explored. There is a very old paper by Moghe (1921) on Betul Satpudas, wherein he enumerated the species there. The hills here in Khandesh are of amygdoloidal trap flows or of softer variety of Deccan trap. Sedimentary beds are often calcarious. Toranmal hill plateau is of the Deccan trap origin. On the top of it there is only a small red clay layer. In summer months hot winds blow every where. Annual rainfall is between 731.8 mm at Chopda and 767.9 mm at Yawal. It is slightly more about 789.7 mm at Taloda. Sometimes Raver gets more than 38″ (965 mm) of rain whereas Akrani and Toranmal get as low as 16-13″ (406-340 mm) generally. Humidity is highest in the months of July and August. Mean annual maximum temperature at Raver 99.56°F, Yawal 101.79°F., Chopda 93.31°F, Shirpur 100.49°F and at Shahada 95.26°F. Dust storms occur occasionally in July, August and October.

Satpudas start from Mahadev hills from Chauragarh in Madhya Pradesh (Alt.4200') (1276 mm) and extend westwards to Burhanpur, and Nimar in Madhya Pradesh and thence to Khandesh.

Broadly speaking eastern region of Satpudas is rich in vegetation having some humid and semi-evergreen species. The middle region of it lies in Khandesh districts and has many deciduous or mixed deciduous species. Western region has only dry scrub in Madhya Pradesh. It breaks into a low woodland or scrub elsewhere.

2. Climate of Dhule (West Khandesh) District and Jalgaon (East Khandesh) District :

Dhule District (West Khandesh)

Climate on the whole is dry, except during south-west monsoons which begin in June and last till about September-October and even upto November sometimes. The average rainfall of the district is 674mm (27″). It is heaviest in the ghat region towards north-west and in Satpuda ranges. For example, Navapur at the north western border gets 1097 mm (44″) rain. 88 % of the rainfall is due to south-west monsoons, it being heaviest in July. Thunder showers are received in post-monsoon period. Once in 50 years rainfall is less than normal and also twice or thrice more, especially in Navapur and Nandurbar.

The annual rainfall for the whole of Dhule district is 674 mm (27") on an average. Rainy days in the year are 42. The temperature in the district begins to rise in the latter part of February to May. May is the hottest month. After the monsoons have stopped in October, temperature begins to rise again in October till November and then goes down.

At Nandurbar the highest temperature is 115°F in May, and the lowest 45·8°F in January. Relative humidity in monsoon is 70 % and in other months 20-25 %. Summer winds blow from south-west to west. Cold waves strike with cold winds from the North. The monsoon winds are variable in directions both at day and night. Relative humidity is 47 % to 35 % when daily mean maximum temperature is around 30 °C. but in April it could be as high as 40°C. The corresponding minimum is 16°C to 25.8°C.

The first authentic record of Khandesh plants is to be found in Cooke (1904-1908) *The Flora of Bombay Presidency* including Gujarat, Sindh and Karnatak. In this work he has described for the whole of Bombay Presidency 2530 species belonging to 969 genera spread over 142 families. Here he mentioned only 68 species belonging to 46 genera and 33 families as occurring in Khandesh due to meagre collections made in Khandesh. Localities mentioned therein are vague and often given in the broadest terms such as "Khandesh", common throughout India or " the Bombay Presidency " with no special reference to Khandesh. This is unhelpful.

Jalgaon District (East Khandesh)

The climate is dry except in monsoon which appears in June and lasts till September. But it may continue in October. Annual mean rainfall is between 740.7 mm. The average rainy days are 45, but 48 at Jamner, 42 at Chopda, Amalner and Parola. Rain is fairly well distributed. December is the coldest month. Heaviest rainfall is in July, sometimes in September. The latter proves very helpful to *Rabi* crops.

Temperature.—Annual maximum temperature is about 47 ° C and minimum 11.9°C. Relative humidity varies from 60.30 to 86.65 %. At Jalgaon wind speed on an average is 11.1 km per hour. Jalgaon is the hottest place in the district.

Soils are alluvial on the banks of river, elsewhere there are black cotton soils derived from traps. They are deep with a fair amount of calcium. Some soils give a Saline reaction, particularly soils of dry deciduous forests of *Tectona grandis* in Yawal range.

There are hot water springs at Unabdev near Chopda in Jalgaon district, but its algal flora or radio-activity have not been studied.

There are only dry deciduous forests in Satpudas in Khandesh.

Composition of Dry deciduous forests and their soil profiles are given below.

Subsidiary Edaphic type :—Hardwickia binata-Anjan forest.

Edaphic climax unit. *Hardwickia binata* facies

Locality :—Satpuda forest.

Station.—(289 Mtrs.) Pal (Raver Range).

Height.—95° Altitude.

Relief.—Hill slopes.

Drainage condition.—Good

Sub-soil water table.—Fairly deep.

Floristic composition :

I. *Hardwickia binata. Anogeissus latifolia, Boswellia serrata, Acacia catechu, Terminalia tomentosa, Pterocarpus marsupium, Dalbergia latifolia.*

II. *Gymnosporia montana, Zizyphus rugosa.*

III. *Butea frondosa, Apluda varia, Andropogon contortus.*

Horizon	Depth in inches	Description	Sample depth.
I	0—10	Dark brown soil, penetrated by roots, dry, of trees, pH 6.2.	9—10
II	10—20	Redoish brown, stony, compact pH-5.4.	10—20
III	20—27	Red stony, compact with few roots, pH 5.2.	20—27
IV	27—35	Blackish grey with reddish tinge, compact pH 5.0.	27—35
V	35—50	Blackish grey, compact, plenty with calcareous nodules pH 7.4.	35—50
	Below 50	Murum.	

3. Soil Profiles of Dry Deciduous Forest of Tectona Grandis (or Dry Teak Timber Forest)

Teak or Tectona grandis (*Timber forest*)

Adina cordifolia Association

Locality-Satpuda Range

Station-Yawal (374 mtr.)

Height-1230' altitude

Relief-Hill slopes

Drainage condition-Good

Sub-soil water table-Deep

Floristic composition :

I. *Tectona grandis, Adina cordifolia, Terminalia tomentosa, Mitragyna Parvifolia, Boswellia serrata, Ougeinia Cojeinensis, Anogeissus latifolia, Dalbergia latifolia, Pterocarpus marsupium, Diospyros melanoxylon.*

II. *Dendrocalamus strictus, Andropogon halepensis*

Horizon	Depth in inches	Description	Sample depth
(1)	(2)	(3)	(4)
I	0—7½	Brown-black penetrated by roots, dry, granular, pH 4.0	0—7½
II	7½—18	Deep black penetrated by roots, wet, planty, pH. 5.6	7½—18
III	18—26	Greyish black, compact, wet, platy, small fragments of disintegrated trap, pH 5.4	18—26
IV	26—37	Compact, grey, brown, nodular pieces of lime-stones, small pieces of disintegrated trap, pH 6.2	26—37
V	37—48	Yellowish-chocolate brown calcareous, pH 7.2	37—48
	Below 48	Murum.	

4. Plants of Satpudas in Khandesh and Adjoining Region

Name	Locality
RANUNCULACEAE	
Clematis smilacifolia Wall ..	Akrani.
DILLENIACEAE	
Dillenia pentagyna Roxb. ..	On slopes of Satpudas.
ANNONACEAE	
Annona squamosa Linn. ..	Plateau of Toranmal, Raver, Shirpur, Chopda ranges.
Miliusa tomentosa (Roxb.) Sinclair =*Saccopetalum tomentosum* Hook. f. and Thoms.	Bund of Toranmal Lake.
PAPAVERACEAE	
Argemone mexicana tinn. ..	Shirpur, Chopda, Yawal ranges.
CAPPARIDACEAE	
Cleome viscosa Linn.: ..	Shirpur, Chopda, Yawal ranges.
Cleome chelidonii Linn. ..	Ranipur.
Cleome simplicifolia (Comb.) Hook. f. and Thoms.	Raver range.
Gynandropsis gynandra (Linn.) Brig. =*Gynandropsis pentaphylla* DC.	
Capparis decidua (Forsk.): ..	Akrani.
Capparis zeylanica Linn. (non *C. zeylanica* HK. f. and Thoms.) =*Capparis horrida* Linn.	In Betul also.

Name	Locality
BIXACEAE	
Cochlospermum religiosum (Linn.) Alston. ..	Toranmal.
VIOLACEAE	
Hybanthus enneaspermus Linn. .. =*Viola-enneasperma* Linn. *Ionidium heterophyllum* Vent.	Betul.
FLACOURTIACEAE	
Flacourtia occidentalis Hook. f. ..	Akrani.
=*Flacourtia ramontchi* L. Herit	Girna River-Jalgaon, Padmalaya.
Flacourtia indica (Burm.) Merr.	Sitaki Nahani, Toranmal Plateau.
Flacourtia sepiaria Roxb. ..	Raver range.
PORTULACACEAE	
Portulaca oleracea Linn. ..	Beds of River Aner and Arunavati.
Portulaca quadrifida Linn. ..	Sandy beds-Arunavati River.
TAMARICACEAE	
Tamarix dioica Roxb. ..	Bank of Aner River.
GUTTIFERAE	
Garcinia spicata (W. and A.) Hook. f.	Behind Forest Dak Bungalow, Akrani.
MALVACEAE	
Sida veronicaefolia Lamk. .. =*S. humilis*.	Near Forest village, Akrani.
Sida spinosa Linn.	Lalmati, River Range.
Kydia calycina Roxb.	Akrani.
Abutilon graveolens Wight and Arn.	Akrani.
Urena lobata Linn. =*Urena sinuata* Linn. ..	In clearings of Pal and Raver range.
Hibiscus hirtus Linn.	In clearings, Shirpur range.
Hibiscus lampas Cav. .. =*Thespesia lampas* Dalz. and Gibs.	Near Ranipur Forest Depot, Yawal range, Shirpur range.
Ceiba pentranda (L) Gaertn. =*Eriodendron anfractuosum* DC.	On steep slopes of Akrani, Dhadgaon.
BOMBACACEAE	
Salmalia malabarica (DC.) Schott and Endl. =*Bombax malabaricum* DC. =*Gossampinus malabarica* (DC.) Alston.	Akrani, common in Raver, Shirpur, Chopda and Yawal ranges, Toranmal—on steep slopes.
STERCULIACEAE	
Sterculia urens Roxb. ..	Toranmal plateau, Raver, Yawal Akrani, Ajantha ranges, on steep rocky ledges.
Sterculia villosa Roxb. ..	Akrani—on lower slopes.
Firmiana colorata (Roxb.) R. Br. =*Sterculia colorata* Roxb.	Shirpur range.

Name	Locality
Helicteres isora Linn.	On Pal, Toranmal plateau and Raver, Shirpur, Chopda, Yawal ranges, Akrani behind the Forest Dak Bungalow.
TILIACEAE	
Grewia tiliaefolia Vahl.	Toranmal plateau and Raver, Virapur, Chopda, Yawal ranges.
Grewia pilosa Lam.	Shirpur, Akrani, Taloda, Shahada ranges.
Triumfetta pilosa Roth ..	Akrani.
Corchorus capsularis Linn. ..	Akrani.
RUTACEAE	
Aegle marmelos Correa	Raver, Shirpur, Chopda, Yawal, Panch Pandava ranges, beside Shiva's temple Padmalaya.
Fagara budrunga Roxb. .. =*Zanthoxylum budrunga* DC.	Akrani on the slopes of Forest Dak Bungalow.
Zanthoxylum rhetsa (Roxb.) DC. =*Fagara rhetsa* Roxb.	
Feronia limonia (Linn.) Swingle =*Limonia acidissima* Linn.	Akrani, Padmalaya, Raver, Chopda, Shirpur, Betul.
=*Schinus limonia* Linn.	Toranmal plateau.
SIMARUBACEAE	
Balanites aegyptiaca (Linn.) Delile	Yawal Range, Akrani, Padmalaya; also in Betul.
Balanites roxburghii Planch. ..	Taloda near forest depot.
Ximenia aegyptiaca Linn. .. =*X. americana*.	Jalgaon on banks of Tapi river.
Ailanthus excelsa Roxb. ..	Toranmal plateau near the smaller lake, Raver, Chopda, Yawal ranges, Jalgaon beside G. P. C. and other places, Betul.
BURSERACEAE	
Boswellia serrata Roxb. ..	Teak pole jungles, Khandesh, Satpuda, Toranmal plateau, Raver, Shirpur, Chopda, Yawal ranges, Akrani on the slopes.
Commiphora mukul Hook ex Stocks. =*Balsamodendron mukul* Hook ex Stocks.	Khandesh and also in Betul Satpuda, Raver range near Lalmati.
Garuga pinnata Roxb. ..	Khandesh, Raver, Chopda, Shahada, Taloda ranges, Akrani, Langada-Amba.
MELIACEAE	
Azadirachta indica A. Juss. ..	Khandesh.
Melia azadarach Linn. ..	Pal, Toranmal plateau, Raver, Yawal, Shirpur, Chopda, Akrani, Raver, Chopda ranges, Akrani.
Chloroxylon swietenia DC. ..	Khandesh, Shirpur, Chopda, Taloda ranges.

Name	Locality
Soymida febrifuga (Roxb.) A. Juss.	Khandesh jungles, Raver, Taloda, Shahada ranges, Akrani.
Toona ciliata Roem. .. =*Cedrela toona* Roxb.	Taloda range.
CELASTRACEAE	
Gymnosporia spinosa (Forsk.) Fiori. =*Gymnosporia montana* Benth *Celastrus senegalensis* Lamk.	Khandesh, Toranmal plateau near the smaller lake, Akrani on slopes, Padmalaya.
RHAMNACEAE	
Zizyphus mauritiana Lamk. .. =*Zizyphus jujuba* Lamk.	Khandesh jungles, Betul, Toranmal plateau, Raver, Chopda, Yawal, Taloda, Shahada ranges.
Zizyphus oenoplia (Linn.) Mill ..	Betul, Toranmal plateau, Yawal, Akrani, Padmalaya, on the banks of river Vaghur.
Zizyphus rugosa Lamk. ..	Toranmal plateau, Yawal range Panch-Pandavas, Akrani.
Zizyphus xylopyra Willd. ..	Toranmal plateau, Yawal range Akrani.
AMPELIDACEAE	
Cissus elongata Roxb. .. .. = *Vitis elongata* Wall.	Shirpur, Chopda, Taloda ranges, Ranipur, Langada-Amba, Lalmati.
Cissus repanda Vahl. .. .. =*Vitis repanda* Wight and Arn.	Khandesh, Toranmal plateau, Shahada range, Akrani.
SAPINDACEAE	
Schleichera oleosa (Lour.) Oken =*Schleichera trijuga* Willd.	Khandesh, Shirpur, Taloda, Shahada, Akrani, Ranipur, Laling, Dhule.
Dodonaea viscosa (Linn.) Jacq. ..	Raver Forest Dak Bungalow, Bhusaval, Dhule, Jalgaon.
ANACARDIACEAE	
Mangifera indica Linn. ..	Wild in Khandesh, Toranmal plateau, Raver, Shirpur, Chopda, Yawal, Shahada, Taloda ranges, Akrani, Langada-Amba, Panch-Pandav, Ranipur.
Anacardium occidentale Linn. ..	Raver range.
Lannea coromandelica (Houtt.) Merr. =*Lannea grandis* (Dennst.) Engler.	Raver, Shirpur, Chopda, Yawal ranges, Langada-Amba.
Odina wodier Roxb.	
Buchanania lanzan Spreng.	Akrani.
= *Buchanania latifolia* Roxb.	Pal, Toranmal plateau in ravines ranges, Yawal range, Akrani, Sindva pass, Boradi, Langada-Amba.

Name	Locality
Rhus myseonnsis Heyne ..	Boradi, Sindva pass, Raver range, Langada-amba.
Semecarpus anacardium Linn. f.	Raver range.
Spondias pinnata (Linn. f.) Kurz =*Spondias mangifera* Willd.	Akrani.
MORINGACEAE	
Moringa oleifera Lamk. .. =*Moringa pterygosperma* Gaertn.	Raver Forest Dak Bungalow.
LEGUMINOSAE	
Heylandia latebrosa DC ..	Pal, Raver range, Shirpur range, Chopda range, Yawal range, Akrani.
Crotalaria sericea Retz. ..	Raver range, Burhanpur Fort.
Indigofera linifolia Retz. ..	Raver range, Chopda range, Shahada range, Ellichpur.
Psoralea corylifolia Linn. ..	Toranmal plateau, Raver range, Gawilgad hills, Burhanpur Fort, Ellichpur.
Alysicarpus vaginalis (Linn.) DC	Khandesh jungles, Surat, Toranmal plateau, Ranipur, Akrani.
Alysicarpus bupleurifolius (Linn.) DC.	Raver range, Yawal range, Ellichpur.
Desmodium gangeticum (Linn.) DC	Chopda range, Khandesh ravines, Shirpur range, Shahada range, Sindva pass, Boradi.
Erythrina variegata Linn. ..	Satpuda forests.
Var. *orientalis* (Linn.) Merr. .. =*Erythrina indica* Lamk.	Raver range, Burhanpur forest, Ellichpur.
Erythrina suberosa Roxb. ..	Khandesh, Raver range.
Erythrina stricta Roxb. ..	Pal, Raver, Langada-Amba, Boradi.
Butea monosperma (Lamk.) Taubert. =*Butea frondosa* Koenig. ex Roxb.	Khandesh, Pal, Raver, Shirpur, Chopda, Yawal ranges, Langada-Amba, Sindva pass, Boradi, Taloda range, Dhule.
Butea superba Roxb.	Pal, Raver range, Shirpur range, Ranipur.
Pueraria tuberosa (Roxb.) DC ..	Toranmal plateau, Taloda range, Ranipur forest depot, near Suki river.
Phaseolus trilobus Ait. ..	Shahada range, Sindva pass, Boradi.
Phaseolus semierectus Linn. ..	Akrani.
Atylosis sericea Benth. ..	Raver range, Chopda range, Yawal range.
Cylista scariosa Roxb. ..	Pal, Raver range, Yawal range, Burhanpur Forest, Akrani.
Dalbergia latifolia Roxb. ..	Khandesh, Pal, Toranmal plateau, Raver, Shirpur, Chopda ranges, Ranipur, Langada-Amba.
Dalbergia lanceolaria Linn. ..	Khandesh, Chopda range, Yawal range, Sindva pass, Ranipur, Langada-Amba.

Name	Locality
Dalbergia paniculata Roxb. ..	Pal, Toranmal plateau, Shirpur range, Boradi.
Dalbergia rostrata R. Grah. ..	Pal, Chopda range, Yawal range.
Pterocarpus marsupium Roxb.	Rajpipla hills, Taloda range, Akrani.
Cassia fistula Linn.	Pal, Raver range, Chopda range.
Cassia tora Linn.	Pal, Raver range, Akrani, Taloda range, Shahada range.
Cassia absus Linn.	Toranmal plateau, Taloda range, Akrani—on slope.
Bauhinia vahlii Wight and Arn.	Akrani ravines.
Bauhinia purpurea Linn. ..	Khandesh, Akrani.
Mimosa hamata Willd. ..	Toranmal plateau, Shirpur range, Chopda range, Yawal range.
Acacia arabica Willd. .. .. =*A. nilotica*	Khandesh jungles, Shirpur, Chopda, Yawal ranges, Boradi, Sindva pass.
Acacia ferruginea DC.	Shirpur, Taloda, Shahada, Chopda, Yawal ranges, Boradi, Sindva pass.
Albizzia lebbeck (Linn.) Benth. ..	Khandesh, Taloda range, Shirpur range, Ranipur.
Albizzia odoratissima (Linn. f.) Benth.	Khandesh, Shirpur range, Taloda range, Boradi, Sindva pass.
Albizzia procera (Roxb.) Benth.	Akrani.
A. pinnata Willd.	Khandesh, Shirpur range, Shahada range, Sindva pass.
Albizzia amara Boiv.	Khandesh Jungles, Sindva pass.
Abrus precatorius Linn.	Toranmal plateau, Raver, Shirpur, Chopda, Yawal ranges, Akrani.
Adenanthera pavonia Linn. ..	Khandesh, Toranmal plateau, Akrani.
Caesalpinia sepiaria Roxb. ..	Akrani.
Caesalpinia bonduc ((Linn.) Roxb. =*Caesalpinia bonducella* (Linn.) Fleming.	Shirpur range.
Hardwickia binata Roxb. ..	Khandesh, Raver range, Chopda range.
Milletia auriculata Baker ..	Pal, Shirpur range, Raver range.
Neptunia triquetra Benth. ..	Pal, Raver range.
Ougeinia oojeinensis (Roxb.) Hochreut.	Khandesh.
=*Ougeinia delbergioides* Benth...	Pal, Raver range, Taloda range, Shirpur range, Shahada range, Akrani.
Parkinsonia aculeata Linn. ..	Betul, Yawal range, Shirpur range, Boradi.
Rhynchosia bracteata Benth. ex Baker.	Banks of Girna river.
=*Rhichosia mollissima* Dalz.	Banks of Tapi.
Rhynchosia minima DC	Akrani.
Shuteria vestita Wight and Arn.	Pal Jungles, Raver range, Laugada-Amba, Boradi.
Taverniera nummularia DC ..	Khandesh, Toranmal plateau, Taloda range, Sindva pass.

Name	Locality
Tamarindus indica Linn.	Khandesh Toranmal plateau, Taloda range, Sindva pass.
CRASSULACEAE	
Bryophyllum pinnatum (Lamk.) Oken.	Shirpur range.
Bryophyllum calycinum Salisb. ..	Boradi Forest Dak Bungalow.
COMBRETACEAE	
Terminalia bellerica (Gaertn.) Roxb.	Khandesh, Taloda Range, Shirpur, Shahada Range, Akrani in the ravines.
Terminalia chebula Retz.	Khandesh, Taloda range, Tajudin Vali in ravine on Panch-Pandav Peak.
Terminalia arjuna Bedd.	Taloda range.
Terminalia tomentosa Wight and Arn.	Khandesh, Taloda range, Shirpur range, Shahada range, Tajudin Vali in ravines.
Anogeissus latifolia Wall. ..	Raver range, Sindva pass.
Quisqualis indica Linn.	Akrani Forest Dak Bungalow.
MYRTACEAE	
Syzygium cumini (Linn.) Skeels	Khandesh, Pal.
=*Eugenia jambolana* Lamk. ..	Toranmal plateau, Raver range, Taloda range, Shahada range, Boradi.
LECYTHIDACEAE	
Careya arborea Roxb.	Khandesh, Taloda range, Shahada range, Langada-Amba, Panch-Pandav, Akrani in ravines.
LYTHRACEAE	
Woodfordia fruticosa (Linn.) Kurz.	Khandesh.
=*Woodfordia floribunda* Salisb. ..	Toranmal plateau, Taloda range, Boradi.
Lagerstroemia parviflora Roxb. ..	Taloda East range, Sindva pass, Panch Pandav, Akrani.
SAMYDACEAE	
Casearia glomerata Roxb. ..	Khandesh, Taloda range in the ravines.
CARICACEAE	
Carica papaya Linn.	Cultivated in Raver range, in the Forest Dak Bungalow, Raver.
BEGONIACEAE	
Begonia concanensis DC	Akrani in the ravines.
CACTACEAE	
Opuntia elatior Mill .. .. =*Opuntia dillenii* Graham	Toranmal plateau, Akrani.

Name	Locality
MOLLUGINACEAE	
Glinus lotoidea Linn. .. .. =*Mollugo hirta* Thub.	Yawal range.
Trianthema portulacastrum Linn.	Satpuda.
UMBELLIFERAE	
Centella asiatica (Linn.) Urb.	Raver range on the sandy banks of Arunavati river.
RUBIACEAE	
Adina cordifolia (Roxb.) Hook.	Taloda range, Shirpur range, Chopda range, Boradi, Sindva pass.
Mitragyna parvifolia (Roxb.) Korth. =*Stephegyne parvifolia* Korth.	Toranmal plateau, Taloda range, Shahada range, Shirpur range, Yawal range.
Oldenlandia herbacea (Linn.) Roxb. =*Oldenlandia heynii* R. Br.	Shirpur range.
Mussaenda glabrata (Hook. f.) Hutchin. =*Mussaenda frondosa* Linn. P. P.	Khandesh, Taloda range, Shahada range, Akrani.
Gardenia resinifera Roth. .. =*Gardenia lucida* Roxb.	Chopda range.
Gardenia gummifera Lihn. ..	Khandesh, Taloda range, Shahada range, Akrani—on the slopes of the 1st range from Forest Dak Bungalow.
Gardenia turgida Roxb.	Pal, Shirpur range, Chopda range, Langada-Amba.
Meyna laxiflora Roxb.	Toranmal plateau, Shahada range.
=*Vangueria spinosa* Roxb. ..	Shirpur range, Boradi, Sindva pass.
Ixora arborea Roxb. Ex. Sm. ..	Khandesh, Satpudas, Raver range,
=*Ixora parviflora* Vahl. non Lamk.	Shirpur range, Chopda range, Taloda range, Shahada range, Boradi.
Ixora coccinea Linn.	Pal jungles, Raver range, Yawal range.
Anthocephalus cadamba Moq. ..	Satpudas.
Diplospora apiocarpa Hook. ..	Chopda range.
Knoxia corymbosa Willd. ..	Raver range.
Morinda citrifolia Linn.	Khandesh, Raver range.
Morinda tinctoria Roxb.	Khandesh, Raver range.
Borreria stricta (L.) Schum. ..	Satpudas.
=*Spermacoce stricta* Linn. ..	
COMPOSITAE	
Vernonia cinerea (Linn.) Less. ..	Taloda range.
=*Conyza cinerea* Linn.	Shahada range, Shirpur range, Chopda range, Yawal range, Akrani.

Name	Locality
Elephantopus scaber Linn.	Taloda range.
Ageratum conyzoides Linn. ..	Yawal range, Akrani.
Grangea maderaspatana (Linn.) Poir.	Toranmal plateau, Raver range, Shirpur range, Chopda range, Yawal range, Akrani.
Conyza stricta Willd.	Toranmal plateau, Yawal range, Chopda range, Yawal range, Akrani.
Sphaeranthus indicus	Toranmal plateau—in cultivated fields near the lake.
Vicoa indica (Willd.) DC .. =*Vicoa auriculata* Cass.	Satpuda, Toranmal plateau on barren slopes.
Caesulia axillaris Roxb.	Chopda range, Yawal range, Raver range, fallow areas after first showers of rain.
Lagasca mollis Cav.	Raver range, Langda-Amba.
Eclipta prostrata (Linn.) Linn. =*Eclipta alba* (Linn.) Hassk. =*Eclipta erecta* Linn. =*Verbesina prostrata* Linn.	Toranmal plateau, Akrani.
Tridax procumbens Linn. ..	Raver range, near Pal, Forest Dak Bungalow.
Emilia sonchifolia (Linn.) DC. =*Cochalia sonchifolia* Linn.	Pal, Raver range, Shirpur range, Chopda range, Yawal range, Akrani.
Sonchus arvensis Linn.	Raver range.
Volutarella ramosa (Roxb.) Santapau. =*Volutarella divaricata* Benth and Hook. f.	Raver range.
Glossocardia bosvallea (Linn. f.) DC.	Satpudas.
Echinops echinatus DC	Toranmal plateau, Yawal range, Shirpur range, very common in felled forest areas on stony ledges.
MYRSINACEAE	
Embelia robusta Roxb.	Akrani.
SAPOTACEAE	
Madhuca indica Gmel. .. .. =*Bassia latifolia* Roxb.	Taloda range, Shahada range. Akrani.
Mimusops elengi Linn.	Akrani—near the Forest Depot.
Manilkara hexandra (Roxb.) Dub. =*Mimusops hexandra* Roxb.	Taloda range, Shahada range,
Achras sapota Linn.	Akrani.
BENACEAE	
Diospyros chloroxylon Roxb. ..	Toranmal plateau, Shirpur range, Shahada range, Chopda range, Yawal range, Sindva pass.
OLEACEAE	
Jasminum multiflorum (Burm. f.) Andr. =*Jasminum pubescens* (Retz.) Willd.	Pal Forest,

Name	Locality
Nyctanthes arbor-tristis Linn. ..	Appears to be wild in Akrani, Toranmal plateau, Taloda range, Shahada range, Sindva pass.
Olax scandens Roxb.	Khandesh, Akrani in the ravines, Toranmal plateau.
Schrebera swietenioides Roxb. ..	Raver range, Chopda range, Akrani, Toranmal plateau, Shahada range, Chopda range.
APOCYNACEAE	
Carissa congesta Wight .. .. =*Carissa carandas* Graham non Linn.	Toranmal plateau, Yawal range, Akrani.
Alstonia scholaris (Linn.) R. Br.	Raver range, Pal village.
Holarrhena antidysenterica (Linn.) Wall.	Chopda range.
Wrightia tinctoria R. Br.	Khandesh, Toranmal plateau, Akrani.
Nerium indicum Mill. .. .. =*Nerium odorum* Soland.	Chopda range-Forest depot.
Ichnocarpus frutescens R. Br. ..	Satpudas.
ASCLEPIADACEAE	
Hemidesmus indicus (Linn.) Br. .. =*Periploca indica* Linn.	Raver range, Shirpur range, Chopda range.
Cryptolepis buchanani Roem. and Schult.	Khandesh, Shirpur ranges, Boradi, Sindva pass, Akrani.
Cryptostegia grandiflora Br. ..	On the banks of Arunavati, Akrani.
Calotropis gigantea (Linn.) R. Br.	Raver range, Sindva pass, Boradi.
Sarcostemma intermedium DC. ..	Khandesh Forest.
Marsdenia volubilis (Linn. f.) Cooke. =*Dregia volubilis* Benth. ex Hk. f.	Akrani.
GENTIANACEAE	
Contaurium roxburghii (G. Don) Druce.	Raver range, near Forest village tank of Chandasaili.
Conscora diffusa R. Br. .. .. =*Canscora lawii* Wight	Shirpur range, Sindva pass.
Conscora decurrens Dalz. ..	On the banks of Aner river, Taloda range.
Enicostemma verticillatum (Linn.) Engl. =*Enicostemma littorale* Blume.	Satpudas.
Hoppea dichotoma Willd	Pal jungles.
BORAGINACEAE	
Cordia macleodii Hook	Khandesh, Shahada range, Shirpur range, Sindva pass.
Cordia dichotoma .. .. .. =*Cordia myxa* auct. non. Linn.	Taloda range, Shahada range.
Cordia wallichii G. Don.	Khandesh, Akrani.
Heliotropium indicum Linn. ..	Very common in waste heaps in forest villages—Chopda range, Yawal range.

Name	Locality
Trichodesma amplexicaulae Roth..	Raver range.
=*Trichodesma zeylanicum* R. Br.	On the banks of Arunavati river,
CONVOLVULACEAE	
Cuscuta reflexa Roxb.	Raver range.
Evolvulus alsinoides Linn. ..	In dry puddles, Yawal range.
Convolvulus arvensis Linn. ..	Taloda range.
Convolvulus pluricaulis Chois ..	Taloda range.
Ipomoea campanulata Linn. ..	Khandesh, Taloda range, Shahada range, Shirpur range.
Ipomoea reniformis Chois. ..	In Betul Satpudas.
Rivea hypocrateriformis Chois. ..	Pal jungles, Raver range, Akrani.
SOLANACEAE	
Solanum nigrum Linn.	Near Raver Rly. station.
Solanum xanthocarpum Schrad and Wendl.	Raver range, Yawal range,
Physalis minima Linn.	Raver range (Fallow area)
Nicotiana tabacum Linn.	Akrani.
SCROPHULARIACEAE	
Scrophularia chinensis Linn. ..	On the dry banks of river Suki, Shahada range.
=*Celsia coromandeliana* Vahl.	
Bacopa monnieri (Linn.) Pennell.	Raver range.
=*Herpestis monniera* Benth.	
Lindenbergia indica (Linn.) O. .. Ktze.	Khandesh, Raver range.
=*Lindenbergia polyantha* Royle ex Benth.	
BIGNONIACEAE	
Dolichandrone falcata Seem. ..	Khandesh, Satpuda, Taloda range, on Toranmal plateau—in the ravines,Akrani—on steep ledges.
Heterophragma quadriloculare.. (Roxb.) K. Schum.	Khandesh, Taloda range.
Stereospermum xylocarpum Wight.	Khandesh, Satpuda, Taloda range.
Radermachera xylocarpa (Roxb.) K. Schum.	Dang jungles, Taloda.
=*Stereospermum xylocarpum* Benth. and Hk. f.	
Tecoma stans (Linn.) Hbk. ..	Khandesh, Taloda range, Shahada range, Raver range.
Tecomella undulata (Smith) Seem.	Khandesh, Taloda, Shahada range.
Millingtonia hortensis Linn. ..	Taloda range—near the Forest Dak bungalow, Shahada range, Shirpur, Chopda, Yawal, Akrani.
PEDALIACEAE	
Martynia annua Linn.	On pathways, in Chopda range.
=*Martynia diandra* Glox.	

Name	Locality
ACANTHACEAE	
Blepharis asperrima Ness ..	An undergrowth in the forest, Taloda, Shirpur range.
Asteracantha longifolia (Linn.).. Ness.	In ditches near the forest village of Ranipur.
=*Hygrophila spinosa* T. Anders.	Taloda range.
Dipteracanthus prostratus (Poir.). Ness.	Shirpur range, Sindva pass, Boradi
=*Ruellia prostrata* Poir. var. *dejecta* Clarke.	
Hemigraphis dura T. Anders ..	Shirpur range, Sindva pass.
Petalidium barlerioides (Roth.)Ness.	Satpudas.
Carvia callosa (Ness) Bremek. ..	Khandesh, an undergrowth in forests where trees are not too dense, Pal, Toranmal plateau, Taloda range, Shirpur range, Chopda range.
=*Strobilanthes* callosus Nees.	
Haplanthus neilgherryensis Wight	Pal jungles.
Barleria prionitis Linn.	Taloda range, Shahada range, Shirpur range, Sindva pass, Boradi.
Lepidagathis trinervia Wall. ..	Pal, Toranmal plateau.
Rungia elegans Dalz. and Gibs. ..	Satpudas.
Ecolium voiride (Forsk.) Alston var. *laetevirens* (Clarke) Raizada	Khandesh, Toranmal plateau.
Justicia diffusa Willd.	Satpudas.
Justicia quinquengularis Koehne ..	Satpudas.
Adhatoda vasica Nees	Khandesh, Toranmal plateau, Taloda range, Shahada range, Raver range.
Peristrophe bicalyculata (Retz.) Nees.	Taloda range.
Eranthemun nervosus (Vahl.) R. Br.	Satpudas.
Daedalacanthus roseus T. Anders	Khandesh jungles.
Tubiflora acaulis O. Kuntze ..	Sindva pass.
VERBNACEAE	
Lantana camara Linn. var. *aculeata* Linn.	Toranmal plateau, Taloda range, Yawal range, Raver range,
Lantana indica Roxb.	Pal jungles.
Phyla nodiflora (Linn.) Greene, =*Lippia nodiflora* A. Rich.	Near Kaladoha, on the way to Toranmal plateau.
Gmelina arborea Roxb.	Khandesh, Taloda range.
Vitex negundo Linn.	At the foot of Yawal range
=*Vitex bicolor* Willd.	
Clerodendrum phlomidia Linn. f.	Khandesh, Taloda range.
LABIATAE	
Ocimum sanctum Linn.	Chopda range, Raver range, Pal Dak bungalow.
Ocimum americanum Linn. ..	Akrani—Forest Dak bungalow.
=*Ocimum canum* Sims.	
Plectranthus mollis (Ait.) Spreng.	On the banks of Arunavati.
Pogostemon paniculatus Benth. ..	Hill slopes.
Colebrookea oppositifolia Smith.	Toranmal plateau,—on the banks of the larger lake, Akrani—common on the slopes.

Name	Locality
Leucas aspera Spreng.	Satpudas, Shahada range, Raver range, very common on the pathways on the forests.
Leucas mollissima Wall.	Satpudas.
Orthosiphon pallidus Royle ..	Satpudas
Lavendula bipinnata O. Kuntze =*Lavendula burmanni* Benth.	Raver range.
NYCTAGINACEAE	
Boerhaavia diffusa Linn.	Taloda, Shahada range, common in lower parts of the range.
AMARANTHACEAE	
Celosia argentea Linn.	Toranmal plateau, Taloda range, very common after rains on slopes.
Amaranthus spinosus Linn. ..	Ranipur—on slopes behind the forest village.
Amaranthus blitum Linn. var. *oleracea* Hook. f. ..	At the foot of Yawal range.
=*Amaranthus paniculatus* Linn. ..	Toranmal plateau, Taloda near hot water spring of Unabdev Sunabdev.
Aerva lanata (Linn.) Juss. ..	Satpudas.
Achyranthes aspera Linn. var. *porphyristacya* Hook. f. ..	Toranmal plateau, Taloda, Shahada range.
Alternanthera sessilis (Linn.) R. Br. =*Alternanthera triandra* Lamk.	In puddles near Forest . village, Taloda range, Shirpur range.,
Digera muricata (Linn.) Mart. =*Digera arvensis* Forsk.	Dhule, Akrani.
Nothosaerva brachiata Wight ..	Dhule, Pal jungles.
Psilostachys sericea Wight ..	Khandesh jungles.
POLYGONACEAE	
Polygonum plebejum R. Br. ..	Pal on the banks of Arunavati river.
PIPERACEAE	
Piper nigrum Linn.	Akrani.
LORANTHACEAE	
Dendropthoe falcata (Linn. f.) Etting. =*Loranthus falcatus* Linn. f.	Satpudas.
SANTALACEAE	
Santalum album Linn.	Taloda range, Shahada range.
EUPHORBIACEAE	
Euphorbia neriifolia Linn. =*Euphorbia ligularia* Roxb. ..	Akrani on the slopes, Toranmal plateau, on rocky ledges, as we pass through bridle tracks from Dara to Mandvi. Toranmal plateau, on steep rocky ledges, near Sitaki-Nahani.
Euphorbia microphylla Lamk. ..	In stream beds in ravines, Taloda, Shahada range.

Name	Locality
Poinsettia pulcherrima R. Graham	Chopda range, near forest depot.
Euphorbia parviflora Linn. ..	Raver.
Euphorbia hypercifolia Linn. ..	Sindva, Raver range.
=*Euphorbia hypercifolia* var. *parviflora* prain.	Boradi.
Euphorbia hirta Linn.	Satpuda ranges.
Euphorbia thymifolia Linn. ..	Satpuda, Akrani, Shirpur range, Sindva pass, Boradi.
Euphorbia splendens Boj. ex Hook.	Akrani.
Acalypha ciliata Forsk.	Satpudas..
Acalypha malabarica Muell Arg.	Satpudas.
Acalypha indica	Taloda range, Shahada range Sindva pass, Boradi.
Chrozophora plicata A. Juss ..	Common in Satpuda.
Mallotus philippinesis (Lamk.) Muell. Arg. ..	Toranmal plateau, Akrani, in the ravines.
Tragia involucrata Linn. ..	Raver range, at the foot of the hills, Akrani.
Ricinus communis Linn. ..	Toranmal plateau, Taloda range,
Fluggea erosa Baill ..	Yawal range, 3rd range, east of forest dak bungalow.
Securinega virrosa Pax and Hoffm.	Akrani.

MORACEAE

Name	Locality
Ficus bengalensis Linn. ..	Toranmal plateau, near the larger lake, besides Shiva's temple..
Ficus religiosa Linn.	Toranmal plateau, near the larger lake besides Shiva's temple.
Ficus lucescens Blume .. .. =*Ficus infectoria* Roxb.	Unabdev-Sunabdev hot springs, Taloda range.
Ficus hispida Linn. f. .. .. =*Ficus oppositifolia* Willd.	
Ficus glomerata Roxb. .. .. =*Covellia glomerata* Moq.	Forest Depot, Yawal range.
Ficus elastica Roxb.	Taloda range, near forest dak bungalow, Chikhaldara plateau.
Ficus tsiela Roxb.	Yawal range near forest depot.
Morus alba Linn.	Chikhaldara plateau, near forest dak bungalow.

CANABINACEAE

Name	Locality
Cannabis sativa Linn.	Akrani.

ORCHIDACEAE

Name	Locality
Habenaria marginata Colebr. ..	In Betul, Satpudas.
Vanda roxburghii R. Br.	

ZINGIBERACEAE

Name	Locality
Kaempfera scaposa (Nimmo) Benth.	In ravines along bridle paths from Nagjhiri to Toranmal
Hedychium scaposum Nimmo.	plateau, Akrani.
Curcuma montana Roxb. ..	Moist regions of Satpudas.

Name	Locality
MUSACEAE	
Ensete superbum (Roxb.) Cheesman. =*Musa superba* Roxb. =*Musa textilis* Graham.	On rocky ledges along bridle tracts from Nagjhiri to Toranmal plateau, also on rocky ledge near Sita-ki-Nahani valley.
HYPOXYDACEAE	
Curculigo orchioides Gaertn. ..	Common under shade of trees, Taloda range, Shahada range, Chopda range.
AMARYLLIDACEAE	
Crinum ensifolium Roxb. ..	In Betul, Satpudas.
Pancratium triflorum Roxb. ..	Forest Dak Bungalow, Raver range.
Pancratium parvum Dalz. ..	Toranmal plateau.
AGAVACEAE	
Agave vera-cruz Mill. ..	Chopda range, in ledges around Agro-Silviculture Farm of Forest Depot.
DIOSCOREACEAE	
Dioscorea bulbifera Linn. ..	Taloda range, Shahada range.
Dioscorea oppositifolia Linn. ..	Taloda, Shahada range, Akrani range.
LILIACEAE	
Asparagus racemosus Willd. ..	Toranmal plateau, Taloda Baker range, Shahada range, Chopda-Yawal range.
Gloriosa superba L. ..	Toranmal, Taloda range, Shahada, Shirpur, Chopda range, Akrani.
SMILACEAE	
Smilax zeylanica Linn. .. =*Smilax macrophylla* Roxb.	Shirpur range, Sindva pass, Boradi.
COMMELINACEAE	
Commelina bengalensis Linn. ..	Toranmal plateau, Akrani.
Murdannia nudiflora (Linn.) Brennan. .. =*Commelina nudiflora* Linn.	Taloda range, Shahada, Raver range, Akrani.
CYPERACEAE	
Cyperus compressus Linn. ..	Raver, Langada-Amba, Akrani.
Cyperus difformis Linn. ..	Toranmal plateau, near the smaller lake.
Cyperus rotundus Linn. ..	Pal, on the banks of Aner river.
Cyperus triceps (Rottb.) Endl. .. =*Kyllinga triceps* Rottb.	Toranmal plateau, Akrani-Raver range.
Cyperus michelianus (Linn.) Link. =*Cyperus pygmaeus* Rottb. =*Juncellus michelianus* Blatt. and Macann.	Taloda range, Toranmal plateau near smaller lake.
Cyperus alopecuroides Rottb. ..	Near Waghur river, Khandesh on the banks of Aner river, Taloda range.

Name	Locality
Cyperus sanguinolentus Vahl .. =*Pycreus sanguinolentus* Nees.	Toranmal plateau, Akrani.
Cyperus malabaricus (Clarke) Cooke. =*Pycreus malabaricus* Clarke.	Toranmal plateau.
Cyperus tuberosus Rottb. ..	Satpudas.
Cyperus pulcherrimus Willd. ..	Akrani, Khandesh.
Cyperus haspans Linn.	Akrani.
Cyperus arenarius Retz. ..	Shirpur range, Sindva pass.
Fimbristylis dichotoma Vahl. ..	Pal, near the stream bed, Akrani.
Fimbristylis digitata Boeck ..	Raver range.
Fimbristylis quinqueangularis Kunth.:	Pal range near the stream bed.
Eleocharis atropurpurea Kunth ..	Toranmal plateau.

GRAMINEAE

Name	Locality
Apluda aristata Linn. ..	Satpuda range.
Apluda varia Hack. =*Apluda mutica* Linn.	
Aristida adscensionis Linn. ..	Taloda range, Toranmal plateau.
Aristida mutabilis Trin. Rupr. ..	Taloda range, Toranmal plateau.
Arthraxon quartinianus Nash .. =*Alectoridia quartinianus* A. Rich. =*Arthraxon ciliaris* Beauv.	Raver hills, Chopda range.
Arundinella pumila (Hochst.) Steud. ..	Khandesh.
=*Arundinella tenella* Nees and Wight.	Raver range, Chopda hills, on the banks of Arunavati river, Taloda range.
Amphilophis odorata A. Camus ..	Toranmal plateau, Akrani.
Dichanthium annulatum (Forsk.) Stapf.	Satpuda ranges.
Andropogon contortus (L.) Roem. and Schult.	Khandesh, Satpudas, Toranmal plateau Taloda range, Shahada range, Shirpur, Chopda range.
Andropogon foveolatus Delile ..	Khandesh Satpudas.
Sorghum halepense Pers. .. .. =*Andropogon halepensis* Brot.	Toranmal plateau, Taloda, Akrani range.
Veteveria zizanioides Linn. Nash. =*Andropogon odoratus* Auct. ex Steud.	Chopda range.
Andropogon pumilus Roxb. ..	Chopda, Yawal range.
Andropogon woodrowii Hook. ..	Khandesh ranges.
Bambusa arundinacea (Retz) Willd. ..	Satpudas in Betul and Khandesh.
Bothriochloa compressus (Hook. f.) Benrard. =*Amphilophis compressa* Blatter and Mcann. ..	Ranipur.
Brachiaria eruciformis (Sibth and Smith) Griseb.	Toranmal plateau, Taloda, Shahada range, Shirpur.
=*Panicum eruciformie* Sibth Smith. =*Panicum isachne* Roth.	Akrani.

Name	Locality
Brachiaria ramosa (Linn.) Stapf. =*Panicum ramosum* Linn.	Toranmal plateau, Taloda range.
Capilllpedium assimile A. Camus.	Akrani, Sindva pass.
Capillipedium hugelii Blatter and McCann.	Khandesh, Akrani, Sindva pass.
Chrysopogon montanus Trinius .. =*Andropogon monticola* Schult.	Akrani range, Chopda hills, Yawal range, Raver range.
Coix lachryma-Jobi Linn.	
Cymbopogon martini (Roxb.) Watson. =*Andropogon martini* Roxb.	Very large and common in all ranges, Taloda range, Shahada range, Shirpur range, Akrani, Raver range.
Cynadon dactylon Linn. Pers. ..	Toranmal plateau, Taloda range, Shahada, Yawal, Raver ranges, Akrani.
Cenchrus biflorus Roxb. ..	Taloda, Akrani.
Chloris incompleta Roth	Toranmal plateau, Akrani.
Chloris tenella Kon.	Raver, Akrani.
Chloris virgata Sw.	Akrani.
Chloris barbata Sw.	Akrani.
Dactyloctenium aegyptiacum Willd. =*Eleusine aegyptiaca* Desv. f.	Pal.
Dichanthium caricosum A. Camus	Raver range, Yawal.
Dichanthium annulatum (Forsk.) Stap f. =*Andropogon annulatum* Forsk.	Toranmal plateau, Taloda, Akrani.
Digitaria adscandens (H. B. K.) Henrard. =*Digitaria marginata* Link. var. *fimbriata* Stapf. =*Paspalum sanguinale* var. *ciliare* H. and *comutalum* Hook f.	Shirpur range.
Digitaria pedicellaris Prain ..	Shirpur range
Digitaria sanguinale Scop ..	Shirpur range
Dinebra retroflexa Panzar ..	Pal, Raver
Tripogon bromoides Roth ..	Banks of Tapi river, Taloda range, on the banks of Aner river
Dendrocalamus strictus Nees ..	Khandesh, Taloda, Yawal range
Echinochloa colona Link. ..	Khandesh in Sahada range.
Eleusine indica (Linn.) Gartner ..	Toranmal plateau, Akrani.
Eleusine flagellifera Nees ..	Chopda range, Yawal range
Eragrostis cilliaris Link. ..	Toranmal plateau, Akrani.
Eragrostis tenella Beauv. var *plumosa* Stapf.	Akrani.
Eragrostis viscosa Trin.	Toranmal plateau, Taloda range.
Eragrostis cilianensis Link. ..	Shahada, Yawal range.
Eragrostis minor Host.	Shahada, Yawal range.
Eragrostis ciliata Nees	Sindva Pass.
Eragrostis coromandelina Trin. ..	Satpudas.
Eragrostis pilosa (Linn.) Beauv. =*Poa pilosa* Linn.	Satpudas.
Eulalia trispicata (Schult) Henrard =*Eulalia argentea* Brongn.	Toranmal plateau, Akrani.
Eremopogon foveolatus Stapf. ..	Akrani.

Name	Locality
Garcilea royleana Hook. f. ..	Taloda, Yawal range.
Heteropogon contortus Rogem and Schult.	Taloda, Yawal range.
Isachne globosa (Thunb.) O. Kuntze.	On the banks of Arunavati river, Raver range
Ischaemum aristatum Linn. ..	Shahada range, Yawal range
Ischaemum pilosum Hack ..	Shahada range, Yawal range.
Ischaemum semisegittatum Roxb.	Shahada range, Yawal range.
Ischaemum laxum R. Br.	Akrani.
Ischaemum spathiflorum Hook. f.	Akrani.
Iseilema anthephoroides Hack. ..	Shirpur range, Yawal range.
Iseilema wightii Anders. ..	On the slopes along bridle tracts from Nagjhiri to Toranmal plateau.
Lophopogon tridentatus Hack. ..	Akrani.
Nazia racemosa Kuntze ..	Akrani.
Oplismenus compositus P. Beauv.	Raver range.
Oplismenus burmanwoii (Retz.) Beauv.	Raver range.
Panicum crusgalli Linn.	Satpudas.
Panicum flavidum Retz.	Satpudas.
Panicum isachne Roth	Satpudas.
Panicum javanicum Poir. ..	Satpudas.
Paspalidium geminatum Stapf ..	Taloda.
Paspalum pedicellare Trin. ex Steud.	Satpudas.
Pennisetum setosum Rich. ..	Taloda range.
Pennisetum ciliare Link. ..	Taloda range.
Perotis latifolia Ait. .. =*P. indica*.	Sindva pass, Shirpur near Tapi river bank.
Phragmites maxima Blatter and McCann.	Toranmal plateau.
Polytoca barbata stapf	Toranmal plateau.
Sehima spathiflorum Blatter and McCann.	Akrani.
Sehima nervosum Stapf	Shirpur range.
Setaria glauca Beauv.	Akrani.
Setaria intermedia Roem. and Schult.	Taloda, Shirpur range.
Sorghum halepense Pers. ..	Taloda, Shirpur range.
Sorghum purpureo-sericeum Aschers and Schweinf.	Yawal range, Raver.
Spodiopogon albidus Benth. ..	Yawal range.
Sporobolus diander (Retz.) Beauv.	Satpudas.
Sporobolus coromandelianus Link.	Akrani.
Saccharum spontaneum Linn. ..	Satpudas.
Themeda triandra Forsk. ..	Toranmal plateau, Taloda range, Shirpur, Yawal, Akrani.
Themeda quadrivealvis O. Kuntz	Toranmal plateau.
Themeda cymbaria Hack. ..	Taloda range.
Tripogon capillatus Jaub. and Spach.	Akrani.
Tripogon jacquemontii Stapf ..	Yawal range.
Thysanolaena agrostis Nees ..	Akrani.
Thysanolaena procera Mey. ..	Akrani.
Urochloa reptans Stapf ..	Toranmal plateau.
Urochloa setigera Stapf. ..	Taloda range, Akrani.

5. Chemical Composition of Some Soils in Khandesh

	1	2	3	4	5	6
Association	*Tectona grandis Terminalia tomentosa*	*Tectona grandis Boswellia serrata*	*Hardwickia binata, Acacia catechu.*	*Acacia catechu*	*Acacia arabica*	*Zizyphus, rugosa Phillanthus emblica*

pH — This varies from 4·0—4·6 in most of the Associations except in 6 where *Phyllanthus emblica* it is 6.00.

$CaCO_2$ in log. of air dry soil. — This shows great variation from 0.002—007, 0.15 in *Boswellia Tectona* association.

Exchangeable: cations Cam.e. in 1000 gm. of soil. — This varies from 4.11—6.12 Phy. (6) association 3.72.

Organic matter in the soil. — This varies much from 1.20 in Acacia to 3-81 in *Tectona, Boswelia serrata* least organic matter is present. *Anogen-Balanite* soils.

Total P_2O_5 — Varies from 0.043 to 0.006.

Silicon — Alumina ratio varies from 2.5 in *Tectona, Boswelia* association soil to 2.96 in *Zizyphus rugosa* association soil
It is lowest 1.92 in *Hardwickia, Acacia catechu* association soil.
In some places soils are strongly alkaline.

6. General Observations on Flora of Khandesh

Khandesh is separated from the Western Maharashtra and also from Vidarbha. It is treated by Hooker and Thomson (1853) as a distinct sub-province botanically. It lies in the lower part of the Tapi valley and is separated from Western Maharashtra by the valley of Godavari which mainly flows through the districts of Nasik, Ahmednagar, Aurangabad, Parbhani and Nanded. Tapi arises at Multai in Madhya Pradesh and flowing westwards, joins the Arabian sea near Kim, near Surat. The upper part of its valley is mountainous in Maharashtra. Once it enters the Gujarat plains it flows slowly through the plains of South Gujarat down to Ukai where a new high level dam is constructed. Ukai is the last mountainous terrain through which it flows.

The other river which flows through Khandesh is Narmada, also going to Arabian sea westwards. But it has a very small part of its basin in Maharashtra, so it does not affect much. We have already described how Khandesh is climatically different from the rest of the table-land of Maharashtra. It is situated between various parallel ranges of Satpudas which are an extension of the spurs of the Sahyadris and lie in continuation with the trends of Vindhyas. The land is mostly flat, plain, the soils are deep, rich black cotton soils : some are alluvial. The whole of Khandesh stands at an elevation of 710′ (216 mtrs.) and its hilly terrain rises a little higher, about 300′ (91 mtrs.) above it. On both sides, the slopes of hills of Ajantha and on the other side of the hills of Satpudas extend and they are flat-topped and plain. The rains though not heavy are well spread and continue long. The sub-soil water table is deep, the humidity lasts throughout rainy season. It is extremely congenial for the growth and production of cotton which is produced abundantly. The districts of Jalgaon and Dhule have nearly the same climate, but as we go east towards Jalgaon, it becomes extremely hot in summer months.

The flora is mostly of the deciduous type in the hills of Satpudas and is not much different from that in other parts of Maharashtra. In many places in the plains there is dry scrub jungle, or a dry thorn Savannah, but on the hilly slopes of mountains, forests are wooded consisting of *Tectona grandis*, *Terminalia arjuna*, *T. tomentosa*, *Adina cardifolia*, *Anogeissus latifolia* in different associations of *Tectona* and *Terminalia*. The rest of it is a thorn Savannah or scrub jungle having *Zizyphus rugosa*, *Acacia* Sp., *Phyllanthus emblica*, *Balanites roxburghii*, *Flacourtia ramontchi*, *Bridelia retusa* etc. The growth of *Tectona grandis* and other tree species here is rather poor. Small trees of *Boswellia serrata*, *Grewia tiliaefobia* *Capparis grandis*, *Capparis divaricata*, *Rhus mysorensis*, *Gymnosporia montana* are abundant. This is in no way different than the flora of dry low hills of Pathardi, Shevgaon, and Ahmednagar talukas of Ahmednagar district.

In many places on the slopes of the hills in Dhule district, we find forests of *Hardwickia binata* and *Anogeissus latifolia*.

The list of species shows most plants of Khandesh especially in Satpuda areas and adjoining territory. It will be seen that there are very few or none humid species but are mostly dry deciduous or scrubby. This is because the climate suffers from extremes. The temperature, humidity and rainfall at Dhule, Chalisgaon, Jalgaon and Bhusawal clearly show it. The black cotton soils beyond Tapi are not very deep. They are often calcareous (See analysis of soil at different places).

7. Some Special Features of Khandesh Flora

Satpuda Mountains Surroundings, and their Flora :

Satpuda mountains form a characteristic feature of Khandesh. They extend through Madhya Pradesh from Betul to Nimar districts, Gawilgarh and Burhanpur. A list of plants in Satpudas in Khandesh is given (pp. 329-346) and those in Betul district as given by Moghe (1921) and other is shown on pp. 348-353. The flora of entire Satpudas is not known, 'Satpuda hypothesis' of Flora is important for the interpretation of the migration of species from North India and Estern Himalayas, Assam, to Peninsular India. A comparison of the two parts of Satpudas will be interesting. In Maval region of Western Maharashtra, the flora between two Mavals is separated by hill ranges, and it gets isolated from each other and becomes distinctive in character for each Maval. Similarly flora between different ranges of Satpudas in Khandesh also develops features of its own in each range. It would be difficult to compare the flora of all the hill ranges of Satpudas, but as an example, one may compare the flora of Yawal or Shahada ranges forming midranges of Satpudas with the extreme end ranges in Raver and Akrani bordering on the territory of Madhya Pradesh.

8. Betul Satpudas

The general height of Khandesh above the plain is 700′-800′ (213-243 Mtrs.) Betul in Madhya Pradesh is largely a hilly area having 2173′-2189′ (652-657 Mtrs.) altitude. The average rainfall is 40-″28″ (992-711 mm.) The number of rainy days are 67. The temperature average varies from 61.5°F in the morning at 8 am. The maximum in the morning goes upto 86°F in May, and to 91°F in June. At 4 p.m. in May it is 102°F, but it comes down soon as the rains begin and falls further in the month of July. There is a slight secondary rise in temperature in the month of October.

The terrain of Satpudas for the greater part in Betul is an undulating table land with stony ridges. But the valley of Machna in Betul on the southern side is a level tract. In valleys on the northern side, soil is alluvial but shallow. In the hilly regions soils are gravel or sandy even on hill tops. Naturally the water gets down the slopes in vallyes very quickly. It supports a thick forest of moist deciduous type. The rainfall annual average is 43″-48″ (992-1119 mm.). Humidity in monsoons is pretty high. The non-living soil cover is formed by dry leaves of the forest trees forming 4″ or 6″ (101 mm. or 152 mm.) thick cover. Naturally one expects a good vegetation under these conditions and so it is. There are 226 known species, spread over 176 genera belonging to 55 families so far recorded. The ratio of monocots to dicots is 1 : 4.3. The principal large families in this region are—

Leguminosae
Compositae
Rubiaceae
Asclepiadaceae
Malvaceae
Acanthaceae
Amarantaceae
Combretaceae
Euphorbiaceae.

The flora is essentially of the herbaceous type, on plains or mixed deciduous type in valley and on slopes, and on the table-land of hill tops. There are 128 herbs, 8 under-shrubs, 14 shrubs whereas trees and lianas are 15. There are no endemic species in this area. Most of the tree species are exactly the same as in Maharashtra forests. Therefore, the vegetation is similar to them. The common woody tree species are : *Tectona grandis, Buchanania latifolia, Mimusops hexandra, Diospyros melanoxylon, Terminalia tomentosa, T. belerica, T. chebula.* On the top of the hill ranges *Schleichera trijuga, Soymida febrifuga, Sterculia urens* grow with many herbacious perennial plants like *Curculigo orchiodes,* and a few grasses. Small trees of *Nyctanthus arbortristis* are many but are confined to slopes and grow to a height of 8′ to 10.′ (203 mm-254 mm.) At the base of the mountain *Bassia latifolia, species* of *Terminalia, Cassia oxidentalis* and small herbacious plants such as *Cassia tora, Cleome chelidonii, Habenaria marginata, Enicostemma littorale, Butea monosperma, Bauhinia purpurea, Semicarpus anacardium, Solanum nigrum* occur in different associations at low heights. *Tectona grandis* wherever it occurs at the base of the hills and in the village it reaches luxurious height and girth. In summer they all shed leaves, and the herbaceous flora gets scorched and dies except the bulbous plants. A special feature of vegetation in Betul is the sporadic occurrence of Sal (*Shorea robusta*).

A perusal of the list of plants in Betul Satpudas suggests mixture of dry and most deciduous species. In dry hill tracts *Cochlospermum gossypium, Butea monosperma, Sterculia urens,* species of *Capparis* and *Flacourtia* occur. They suggest drier conditions. The abundance of *Acanthaceae Labiatae* especially of the genus *Leucas,* palms such as *Phoenix sylvestris* and *Phoenix acaulis, Bombusa arundinacea* and *Dendrocalamus strictus* are commonly seen as in Chhota Nagpur, Bengal plains and Maharashtra. There is however a difference. In any place in Betul *Tectona grandis* and *Terminalia* Spp. or *Bassia latifolia* grow in

large numbers to the extent of 50 per cent of vegetation in the forests. In some places *Tectona grandis* is mixed with *Boswellia serrata* and *Terminalia tomentosa.* Grass grows on open table-land on hill tops, but it dries up in summer. It is very hot and many species resort to various methods of perennation with the help of their underground parts.

List of Plants in Betul Satpudas

(Enumerated by Moghe, 1921)

Name

Papaveraceae :
Argemone mexicana Linn.

Capparideae :
Cleome simplicifolia Hook. f.
C. chelidonii Linn.
C. viscosa Linn.
Gynandropsis pentaphylla DC.
(= *G. gynandra*).
Capparis horrida Linn.

Violaceae :
Ionidium suffruticosum Ging.

Bixineae :
Cochlospermum gossypium DC.
Flacourtia romontchi L.' Herit.

Portulacaceae :
Portulaca oleracea Linn.
Portulaca quadrifida Linn.

Malvaceae:
Sida humilis Willd.
Sida spinosa Linn.
Abutilon indicum G. Don.
A. graveolens W and A.
Urena sinuata Linn.
Bombax malabaricum DC.
Ceiba hexandra Gaitern.

Sterculiaceae:
Sterculia urens Roxb.

Tiliaceae :
Grewia hirsuta Vahl.

Geraniaceae :
Biophytum sensitivum DC.

Rutaceae :
Feronia elephantum Correns.
Aegle marmelos Correvs.

Simarubeae :
Ailanthus excelsa Roxb.
Balanites roxburghii Planch.

Name

Burseraceae :
Boswellia serrata Roxb.
Balsamodendron mukul Hook.

Meliaceae :
Melia azadirach Linn.
M. azadirachta Linn.
Soymida febrifuga Adr. Juss.

Celastrineae :
Elaeodendron glacum Pers.

Rhamneae:
Zizyphus jujuba Lamk.
Zizyphus oenoplia Mill.

Sapindaceae :
Schleichera trijuga Willd.

Anacardiaceae :
Buchnannia latifolia Roxb.
Semecarpus anacardium Linn.

Leguminoseae :
Heylandia latebrosa DC.
Crotolaria sericea Retz.
Indigofera linifolia Retz.
I. enneaphylla Linn.
I. trita Linn.
I. cordifolia Heyne.
Psoralea corylifolia Linn.
Tephrosia purpurea Pers.
Phaseolus trilobus Ait.
Alysicarpus rugosus DC.
A. styracifolius DC.
Ougeinia dalbergioides Benth.
Desmodium gangeticum DC.
Abrus precatorius Linn.
Butea frondosa Roxb. (= *Butea monosperma*).
B. superba Roxb.
Cylista scariosa Roxb.
Rhynchosia minima DC.
Dalbergia sissoo Roxb.
D. latifolia Roxb.
Pterocarpus marsupium Roxb.
Pongamia glabra Venland.
Caesalpinia bonducella Flemming.
Caesalpinia sepiaria Roxb.
Parkinsonia aculeata Linn.
Cassia fistula Linn.
Cassia tora Linn.
C. occidentalis Linn.
C. absus Linn.
Bauhinia racemosa Lamk.
B. Vahli W. and A.
B. variegata Linn.
Mimosa hamata Willd.
Acacia arabica Willd.

Name

A. leucophloea Willd.
A. farnesiana Willd.
A. catechu Willd.
Albizzia odoratissima Benth.
Neptunia triquetra Benth.

Combretaceae :
Terminalia belerica Roxb.
T. chebula Retz.
T. arjuna W. and A.
T. tomentosa W. and A.
Anogeissus latifolia Wall.

Myrtaceae :
Eugenia jambolana Lamk.
Careya arborea Roxb.

Lythraceae :
Woodfordia floribunda Salisb. (= *W. fruticosa* Kurz.)
Lagerstroemia parviflora Roxb.

Ficoideae :
Trianthema monogyna Linn.
Mollugo hirta Thumb.

Umbelliferae :
Hydrocotyle rotundifolia Roxb.

Rubiaceae :
Anthocephalus cadamba Miq.
Adina cordifolia Benth and Hook.
Knoxia corymbosa Willd.
Stephegyne parviflolia Korth.
Oldenlandia aspera DC.
Gardenia lucida Roxb.
Ixora parviflora Vahl.
Spermacoce stricta Linn.

Compasiteae :
Vernonia cinerea Nees.
Grangea maderaspatana Poir.
Conysa stricta Willd.
Caesulia axillaris Roxb.
Glossocardia linearifolia Cass.
Eclipta alba Hassk.
Vicoa auriculata Cass.
Lagasca mollis Cav.
Tridax procumbens Linn.
Emilia sanchifolia DC.
Echinops echinatus DC.
Volutarella divaricata Benth and Hook.
Launaea nudicaulis Hk.

Myrsinaceae :
Embelia robusta Roxb.

Sapotaceae :
Bassia latifolia Roxb.

Name

Ebenaceae :
Diospyros melanoxylon Roxb.

Oleaceae :
Nyctanthes arbor-tristis Linn.

Apocynaceae :
Carissa carandus Linn.
(=*C. congesta* Vatl)
Holarrhena antidysenterica Wall.
Ichnocarpus frutescens Br.

Asclepiadaceae :
Hemidesmus indicus Br.
Cryptostegia grandiflora Br.
Calotropis gigantea Br.
C. procera Br.
Dregea volubilis Benth.
Leptadenia reticulata W and A.

Gentianaceae :
Enicostemma littorale Blume.
Erythria roxburghii Don.
Canscora decurrens Dalz.

Boragineae :
Cordia myxa Linn.
Trichodesma indicum Br.
T. amplexicaula Roth.

Convolvulaceae :
Ipomoea reniformis Chois.
Convolvulus pluricaulis Chois.
Convolvulus arvensis Linn.
Evolulus alsinoides Linn.
Cuscuta reflexa Roxb.

Solanaceae :
Solanum xanthocarpum Sch.
S. nigrum Linn.
Datura fastuosa Linn. var. *alba*.

Scrophulariaeae :
Celsia coromandeliana Vahl.
Herpestis monniera Benth.
Striga euphrabioides Benth.

Pedaliaeae :
Martynia diandra Glax.

Acanthaceae :
Hygrophila spinosa T. Anders.
Ruellia prostrata Lamk.
Petalidium barlerioides Nees.
Daedalacanthus roseus T. Anders.

Name

Justicia diffusa Willd. Var. *vahlii*. C. B. Clarke.
Var prostrata C. B. Clarke.
J. quinqueangularis Roen.
Rungia elegans Dalz.
Peristrophe bicalyculata Nees.

Verbenaceae :
Lantana camara Linn.
Tectona grandis Linn.
Vitex negundo Linn.
Lippia nodiflora Mich.

Labiatae :
Orthosiphon pallidus Royle.
Plectranthus incanus Linn.
Lavandula burmanni Benth.
Pogostemon paniculatus Benth.
Leucas mollissima Wall.

Nyctagineae :
Boerhaavia repens Linn.

Amarantaceae :
Celosia argentea Linn.
Amarantus spinosus Linn.
Aerva lanata Juss.
Achyranthes aspera Linn.
Digera arvensis Forsk.
Alternanthera sessilis Br.

Polygonaceae :
Polygonum plebejum Br.

Loranthaceae :
Loranthus longiflorus Desr.
Viscum angulatum Heyne.

Euphorbiaceae :
Euphorbia pilulifera Linn.
E. rosea Retz.
E. thymiflora Burm.
Phyllanthus emblica Linn.
Jatropha gossypifolia Linn.
Chrozophora plicata A. Juss.
Acalypha malabarica Muell.
Acalypha ciliata Forsk.
Mallotus philippinensis Muell.
Tragia involucrata Linn.

Urticaceae :
Ficus bengalensis Linn.
F. hispida Linn.
F. religiosa Linn.
F. glomerata Roxb.

Orchidaceae :
Vanda roxburghii Br.
Habenaria marginata Coleb.

Name

Scitamineae
Curcuma montana Bak.

Amaryllideae
Curculigo orchioides Gaertn.
Crinum ensifolium Roxb.

Dioscoreaceae
Dioscorea oppositifolia Linn.
D. bulbifera Linn.

Liliaceae
Smilax macrophylla Roxb.
Asparagus racemosus Willd.
Gloriosa superba Linn.

Commelinaceae
Cyanotis axillaris Schult.

Palmeae
Phoenix acaulis Roxb.
P. humilis Royle.

Cyperaceae
Kyllinga triceps Rottb.
Cyperus tuberosus Rottb.
Cyperus rotundus Linn.

Gramineae
Paspalum pedicellare Trin.
P. sanguinale var. *P. ciliare* Lamk.
Panicum isachne Roth.
Panicum flavidum Retz.
P. crus-galli Linn. var. *frument.*
P. colonum Linn.
P. javanicum Poir.
Pennisetum pedicellatum Trin.
Coix lachryma-jobi Linn.
Apluda varia Hack.
Saccharum spontaneum Linn.
Andropogon caricosuss Linn.
A. annulatus Forsk.
A. contortus Linn.
Setaria glauca Beauv.
Setaria intermedia Roem. and Sch.
Chloris barbata Sw.
Dinebra arabica Jacq.
Pseudanthistiria hispida Hook.
Soprobolus diander Beauv.
Cynodon dactylon Pers.
Eragrostis coromandeliana Trin.
E. pilosa Beauv.
Dendrocalamus strictus Nees.
Bambusa arundinacea Willd.

9. Vegetation Types and Important Plant Communities in Khandesh Satpudas

A profile of vegetation in Satpudas in Khandesh was studied by Forest authorities and examining transacts thereof. According to Karnik (1959) there are 6 different forest types of woody species in this region. They may be classified according to rainfall : (389—1143 mm.)

(1) Exceeding 35″ to 45″, Dry deciduous forests representing climatic climax.

Tectona grandis association (Pole type).

Tectona grandis forest (Timber type).

Edaphic climax association is formed by Anjan or *Hardwickia binata.*

(2) Where rainfall is below 25″ (635 mm.) there is only thorn savanah. The composition of these plant communities varies in each.

The most interesting of these are the vegetation types of Toranmal plateau on the slopes of which there is a dry deciduous forest or a sparse wood land or Savannah of *Tectona grandis* and a scrub on the cliffs. The secondary vegetation in the *Tectona grandis* forest consists of *Woodfordia fruitcosa, Butea monosperma, Lantana camara, Vitex negundo* and *Dalbergia sisoo.* In *Hardwickia binata* forest community on the lower ranges, the secondary vegetation consist of grasses like *Andropogon pumilus, Andropogon contortus, Ischaemum segatum,* and also *Butea monosperma,Carvia callosa.* In the poor soils *Tectona grandis,Acacia catechu, Anogeissus latifolia, Holarrhena antidysenterica, Balanites roxburghii, Cassia auriculata, Echinops cephalotus* and *Lantana camara* occur. Near Taloda, small streches of poor trees of *Tectona grandis* are seen, but near Yawal mixed deciduous forest consisting of *Tectona grandis* and *Adina cordifolia* occurs. Bamboos occur sparingly near Ranipur viz. *Dendrocalamus strictus* as brake but near Raver only grasses like *Andropogon halepensis* and *Cymbopogon martinii* are found. On eroded soil trees of *Balanites* and woody thatch grass *Themeda triandra* are common. If protected, the grass-land by stages leads to dry thorn savannah. Grasses, *Mimosa hamata, Acacia leucophloea* form thorn savannah of *Balanites roxburghii* and *Flacourtia ramontchi.* There are various climax plant communities. The climatic climax is illustrated by dry deciduous forests in which *Tectona grandis* is the main species, but the growth of it is poor. It occurs in Akrani, Taloda, Shirpur, Chopda and Yawal. The associates of it are *Terminalia tomentosa, Terminalia balarica, Terminalia arjuna, Lannea grandis, Lagerstroemia parviflora.* But the proportion and sub-dominance of these change at different places, as the water content of the soil in different places such as Akrani, Dhadgaon and Ranipur goes on decreasing. Naturally the size of the woody trees become small.

Their succession here is as follows :—

Tectona grandis, Eugenia dalbergioides.

Adina cordifolia, Anogeissus latifolia.

Boswellia serrta, Pterocarpus monsupium.

Finally it leads to the growth of *Andropogon halpensis.* Where the forests are cleared, grasses grow, and bamboo brakes develop on gradual slopes. On the banks of rivuletes formation of *Hardwickia binata* is

ormed. It represents edaphic climax. They are generally found in ew definite localities on recent alluvium formed from denudation of ocks or erroded soils. It is the soil here which determines germination nd growth of *Hardwickia binata* seeds and the survival of their seedlings. t was shown by Karnik (1959) that black cotton soil when available such s at Pal, it is favourable to *Hardwickia* seedlings. This soil has the ollowing characteristics.

Air content	.. .. ..	25.2 per cent.
Water content	.. ..	24.1 per cent.
Air capacity	.. .. ..	10.5 per cent.
Water capacity	.. ..	40.2 per cent.

ometimes it contains a high ratio of silica sesquioxide.

The third important plant community which is useful in providing wood, or fuel is *Acacia catechu*. *Anogeissus latifolia* is found on the fringe of *Tectona grandis* forest at Shirpur on east and west hill ranges. These orests lie quite adjacent to cultivated lands and are 1 to 2 miles wide. Many of them are comparatively poor and dry. Their growth being poor, he trees are stunted. *Balanites roxburghii*, *Anogeissus latifolia*, *Boswellia serrata*, *Flacourtia ramontchi*, *Zizyphus oenoplia*, *Echinops echinatus*, *Dichanthium annulatun*, *Apluda varia*, *Andropogon pumilus Andropogon contortus* represent primary dry Seral Community.

Over the greater part of Khandesh near the base of Satpuda ranges, and even on some of them the denudation is very great. On the tableland plateau as at Toranmal there is *Zizyphus rugosa*, *Phyllanthusemblica* associations forming a dry thorn scrub or a savannah. They are due to much neglect of area. They also represent climax type of vegetation where the percentage of moisture and organic matter is very low. *Sterculia urens*, *Cochlospermum gossypium*, *Mitragyna parvifolia*, *Zizyphus jujuba*, *Zizyphus oenoplia* represent the edaphic climax. Generally a stable climax is due to climate and it represents the best of vegetation. But whenever there is disturbance due to any reason, it results in secondary vegetation. Which is as a rule poorer than the original vegetation. It never attains height or growth as of original vegetation, much less in deflected climax type. Its form is also different than that of the original vegetation. Secondary vegetation often results in grass-land of a poor type, e. g. on the hills near Dhule and Laling. The zonation of various plant communities is chiefly determined by the moisture present in the soil and rainfall. Examples are Yawal and Chopda ranges where zonation of the vegetation is as follows :—

Altitude	*Zones*
(456—608 mtr.) 1500—2000′ ..	.. *Tectona grandis*, *Adina cordifolia* association.
(274—289 mtr.) 900—950′ ..	.. *Acacia catechu*, *Anogeissus latifolia* association.
(152 mtr.) 500′ ..	.. *Vitex negundo*.
(26—30 mtr.) 250—100′ ..	.. *Cassia auriculata*.
(30 mtr.) Below 100′ ..	.. Grass.

Chief plant communities in Khandesh appear to flourish in the following order showing increasing xerophytism and dependence on rainfall.

Tectona grandis forest

Fuel yielding species such as *Acacia catechu*

Anogeissus latifolia—Dry thorn scrub species

Zizyphus rugosa, Sterculia urens—Dry forest

Thorn savannah of *Hardwickia binata, Balanites roxburghii.*

The existing vegetational changes are due to plant succession.

The plant succession in Satpuda is mainly of the plant communities as shown below :

1. *Tectona grandis—Terminalia tomentosa.*
2. *Tectona grandis, Adina cordifolia, Acacia catechu,*
3. *Anogeissus latifolia, Zizyphus rugosa, Phyllanthus emblica, Balanites roxburghii,* deflection.
4. *Acacia leucophloea.*
5. *Dry Thorn Scrub—Dendrocalamus stricuts* brakes and grass, *Andropagon haplensis.*

It may generally be said that plant climate of Khandesh particularly of Satpuda is of the Phanerophytic type. Their facies resemble the vegetation of Chikhaldara in Amravati district, Parasnath hills in Orissa and Aravalis in Rajasthan. For detailed study of these "Ecology and Forest types" and "*A Preliminary survey of the Forest types of India and Burma*" by Champion (1956) as revised by Champion and Seth (1968) and Mahabale and Kharadi (1946) be consulted.

By far the most interesting vegetation occurs in Khandesh on Toranmal hill range. In Satpuda the vegetation changes from range to range. Vegetation of Toranmal lake reminds one of other lakes, but is in strong contrast with the vegetation of other lakes on the hill top of Sahyadrics such as the Venna lake (Pratap Sagar) at Mahabaleshwar or Lonar lake in Buldhana district. This is not only due to its situation in a relatively dry area, but is due to its origin also. This lake on the top of Toranmal is supposed to be a crater lake of vulconic origin. Such is not the origin of the other lakes. Similarly Telangkhedi lake at Nagpur or the large lake at Umred near Nagpur lie in Deccan trap rocks or in black cotton soil derived from the trap. But the geographical situation and the vegetation surrounding each lake is different and hence the nature and constituents of their flora are different. This becomes apparent when one considers the aquatic plants found in each lake.

Taken as a whole the vegetation of dry deciduous forest or dry thorn scrub plant community in Khandesh is similar to the vegetation found in other parts of Maharashtra. Satpuda ranges in Khandesh constitute a continuation of the Vindhyas but of different origin. Unlike Sahyadri ranges N-S, they extend from NE to SW. They form a high way for the migration of species from Assam, Garo Hills to Sahyadries and farther down to Nilgiri and Malabar. This really is the basis of Satpuda hypothesis considered later.

10. Comparison of Khandesh and Betul Satpuda Flora and those of other Regions of India

The list of plants in Satpudas in Khandesh is given on page No. 327. It will be seen, that at its one end it has more woody semi-evergreen species in Betul Satpudas, whereas at the other end in Raver and Akrani, there are more of dry deciduous species. To mention a few typical ones, one may mention : *Tectona grandis*, *Terminalia chebula*, *Terminalia arjuna Firmiana colorata*, *Ceiba pentandra*, *Dalbergia sisoo*, *Terminalia belerica*, These are typical species of moist deciduous forests, but compared to the Betul Satpudas their proportion in the total plant population is not high as the rainfall in Khandesh is not so much as in Betul and the number of rainy days is less. At the same time there are many dry deciduous species in Khandesh Satpudas the same as in Marathwada or Vidarbha region e. g. *Anogeissus latifolia*, *Cochlospermum gossypium*, *Balanites roxburghii*, *Hardwickia binata*. The vegetation in different parts of Satpudas depends upon the rainfall, its distribution and range of temperature. The hill tops also are very often not thickly populated. Much of the vegetation is on the slopes. But the herbaceous species are plenty. About 50 percent of the species in Satpudas in Khandesh and in Betul are common ; and though major species are the same, the growth of woody species in Betul Satpudas is better. On the other hand the herbaceous species in Betul dry up very quickly due to poor soil. Much of the woody species and vegetation are on slopes and in deep valleys in Betul. Soils also contain more humus in Betul. The terrain between two Satpuda ranges in Khandesh is plain, and in summer does not retain much moisture. The total productivity of Betul Satpudas is greater as the soils there are richer in humus and come under the influence of post-monsoon rains. The humidity temperature and rainfall in Khandesh is more conducive for the growth of cotton and other Rabi crops. Such is not the case with the hilly tract of Betul. The principal families in Khandesh Satpudas are :—

	Species
Gramineae	103
Leguminosae	63
Euphorbiaceae	23
Acanthaceae	18
Rubiaceae	18
Compositae	17
Cyperaceae	16
Asclepiadaceae	10
Labiateae	9
Malvaceae	9

In all in Khandesh there are 484 species spread over 322 genera and 80 families. Compared to this, in Betul Satpudas there are 226 species spread over 176 genera and 55 families. Of these 226 species 128 are

herbs, 8 are under-shrubs, 14 are shrubs, and 13 are lianas. They may b compared with the principal families in Betul region :—

	Genera	*Species*
Gramineae	17	26
Leguminosae	24	38
Acanthaceae	7	8
Malvaceae	4	6
Amarantaceae	6	7
Labiateae	5	6
Rubiaceae	8	8
Asclepiadaceae	5	5
Euphorbiaceae	7	11
Combretaceae	2	5
Capparidaceae	3	5

It will be seen that the dominant families and genera and species are different in the two areas of Satpudas. They may be compared with the families (arranged in the order of abundance) in the adjoining regions of South Gujarat, Vidarbha and Western Maharashtra.

Khandesh Satpudas	*Betul Satpudas*
Gramineae, Leguminosae	Gramineae, Leguminosae,
Euphorbiaceae, Acanthaceae ..	Compositae, Acanthaceae,
Rubiaceae, Compositae, ...	Malvaceae, Labiatae,
Cyperaceae, Asclepiadaceae, ..	Asclepiadaceae, Rubiaceae,
Labiatae, Malvaceae, ...	Capparidaceae, Euphorbiaceae.

South Gujarat	*Gangetic plain*
Leguminosae, Gramineae	Gramineae, Leguminosae,
Cyperaceae, Compositae	Cyperaceae, Compositeae,
Euphorpiaceae, Malvaceae, ..	Scrophulariaceae, Malvaceae,
Convolvulaceae, Orchidaceae ..	Acanthaceae, Euphorbiaceae, Convolvulaceae, Labiatae.

Madhya Pradesh	*Vidarbha*
Leguminosae	Leguminosae, Rubiaceae,
Gramineae	Acanthaceae, Malvaceae,
Compositae	Verbenaceae, Apocynaceae,
Acanthaceae, Euphorbiaceae, ..	Compositae, Caesalpinae
Scrophularia ceae, Verbenaceae, ..	Rhamnaceae, Anacardiaceae,
Labiatae, Malvaceae	Meliaceae.
Amarantaceae.	

It will be seen that the flora of this region resembles more with that of North-East region of India. The family Gramineae is prominent here as well as in the Eastern Himalayas, Aravalis and in the Deccan Flora.

The family Leguminosae occupies second place in Satpudas, in Aravalis, Malaya peninsula. Family Euphorbiaceae occupying third position in Satpudas occupies the same position in Malaya peninsula. The family Acanthaceae occupies the 4th position in Betul Satpudas, but a third position in the flora of Deccan and Malabar. The family Compositae occupies 6th position in the flora here, but it occupies a much higher position elsewhere, third in Gujarat, Aravalis and Sindh. This is to be expected as a large number of Compositae are found in the Desert of Rajputanas, Sindh and Northern Gujarat. The family Cyperaceae having 7th place here is third in Indo-ganga plain. This suggests abundance of water there. The family Asclepiadaceae 8th in Satpudas has no relation whatsoever with the flora of other regions. The family Labiatae has somewhat distant relationship with the Western Himalayan flora. The 10th family Malvaceae is poorly represented in the Satpudas.

The three dominant types of vegetation both in Betul and Khandesh. Satpudas are the same though the component species and their abundance in the two areas is different. (1) Deciduous forests, (2) Scrub or Thorn Savannah, (3) Grassland. These are also the three main types of vegeation in the rest of Maharashtra. However, it should be noted that the grasslands here are not true grasslands. The dominant forests community is dry deciduous forest comprising *Tectona grandis*, *Terminalia tomentosa* and their different association, as given already.

Deciduous Forests :

This type is seen near Taloda where the rainfall is (992—1295 mm.) 40″—52″ as against this quite a different type of forest is seen in Akrani range having rainfall (482—3547 mm.) 19·73″. Naturally the vegetation here is composed of different species which are drought resistant. They are *Ailanthus excelsa*, *Diospyros melanoxylon*. *Clerodendron phlomides*, *Capparis aphylla*, *Bridelia retusa*, *Cassia fistula*, *Feronia elephantum*. The three species *Lannea grandis*, *Anogeissus latifolia*, *Lagerstroemia parviflora* gradually get reduced in size due to decreased water content of the soil. Similar type of vegetation prevails in the *Tectona grandis—Adina cordifolia*, or *Terminalia* association ; the edaphic climax of forest results in *Hardwickia binata* forest.

The final type of vegetation is formed by *Acacia catechu*, *Anogeissus latifolia*. If deflected or degraded due to grazing, fire etc., it results in scrub of *Zizyphus*, *rugosa*, *Phylanthus emblica* association.

On the other hand, the reverain forests representing post-climax vegetation have woody grasses, bamboos, *Flacourtia ramontchia*. Some times there is a mixed deciduous forest on them, e. g. near Yawal. The sequence of these is as follows : Mixed deciduous forest of *Tectona grandis*, *Terminalia tomentosa Tectona grandis-Adina cordifolia Acacia catechu-Anogeissuslatifolia*, *Zizyphusrugosa*, *Phylanthusemblica*. *Balanites roxburghii*, *Acacia leucophloea*, *Hardwickia binata*. The last association represents *Edaphic climax*. Sometimes there is deflection and the dry thorn Savannah leads to bamboo brakes formed by *Dendrocalamus strictus*. Further degeneration results in grassland of *Andropogon halepensis* due to overgrazing or fire. Then only thatch grass *Themeda triandra* then grows there. Very often due to erosion even this changes to *Echinops echinatus* facies. If protected from grazing

or fire, grassland with *Mimosa hamata* and *Acacia leucophloea* develop. It should be noted that in all these soil moisture factor is very much operative and on account of it the vegetation often gets deflected or does reach climax.

The dominant flower colour in Betul Satpudas is light yellow and also in Khandesh Satpudas. In the hot season (March to June) 37 tree species flower. In rainy season (July to October) only 8 species flower, whereas in the cold season (November to February) 26 species flower. As a rule the largest number of species, 49, flower in hot season. This is no doubt due to influence of summer temperature on them rather than any other climatic factor.

Vegetational types may be summarised as follows and their succession is also given below.

Climatic climax type—

1. *Tectona grandis—Terminalia tomentosa* association.
2. *Adina cordifolia—Tectona grandis* association.
3. *Edaphic climax type—Hardwickia binata.*
4. *Anogeissus latifolia—Acacia catechu* association.

SUCCESSION OF CHIEF FOREST COMMUNITIES IN KHANDESH

A. *Dry deciduous plant community :*

Tectona grandis—Terminalia tomentosa association.
Tectona grandis—Adina cordifolia association.
Acacia catechu—Anogeissus latifolia association.
Zizyphus rugosa—Phyllanthus emblica association.
Balanites roxburghii—Acacia leucophloea association.
when deflected due to cutting, fire, or neglect.

B. *Dry thorn savannah :*

Dendrocalamus strictus (Bamboo brakes).
Andropogon halepensis—Cymbopogon martini Association.
Themeda triandra—Echinops cephalotes Association.

If protected grassland with edible grasses—grows mixed with *Mimosa hamata* and *Acacia leucophloea* here and there.

TABLE No. VI—B·1

COMPOSITION OF TECTONA GRANDIS—TERMINALIA TOMENTOSA PLANT ASSOCIATION

Species	F	A	D	S
1. *Tectona grandis*	5	4	2	2
2. *Terminalia tomentosa*	5	4	2	1
3. *Terminalia belerica*	3	4	2	1
4. *Terminalia arjuna*	4	3	2	1
5. *Anogeissus latifolia*	3	4	3	1

F=Frequency; A=Abundance; D=Dominance; S=Sociability.

Species	F	A	D	S
6. *Miliusa tomentosa*	2	3	2	2
7. *Morinda tinctoria*	2	3	2	1
8. *Mitragyna parvifolia*	2	2	2	1
9. *Ougeinla cojeinensis* (?)	..	..	..	..
10. *Sterculia urens*	2	2	3	2
11 *Garuga pinnata*	1	1	2	1
12. *Kydia calycina*	3	3	2	1
13. *Cassia fistula*	3	2	1	1
14. *Lagerstroemia parviflora*	3	1	1	2
15. *Dalbergla paniculata*	2	2	1	1
16. *Schrebera swietenioides*	2	2	1	1
17. *Dalbergia latifolia*	3	3	2	1
18. *Soymida ferbrifuga*	2	2	1	1
19. *Flacourtia ramontchi*	2	3	2	1
20. *Strychnos potatorum*	1	1	2	1
21. *Lonnea coromandelica*	2	3	2	2
22. *Bassia latifolia*	2	3	2	1
23. *Melia azadirachta*	3	4	3	2
24. *Boswellia serrata*	3	4	3	2
25. *Gmelina arborea*	2	2	1	1
26. *Diospyros melanoxylon*	2	2	1	1
27. *Dalichandrone falcata*	2	3	2	1
28. *Careya arborea*	2	3	2	1
29. *Ixora arborea*	3	2	1	1
30. *Diospyros chloroxylon*	2	1	1	1
31. *Pongamia glabra*	2	1	1	1
32. *Ailanthus excelsa*	2	1	3	2
33. *Bridelia retusa*	2	1	2	1
34. *Feronia elephantum*	2	1	1	1
35. *Gymnosporia montana*	2	1	1	1
36. *Albizzia procera*	1	1	1	1
37. *Randla dumetorum*	1	1	1	1
38. *Cordia macleodii*	1	1	1	1
39. *Buchanania latlfolia*	1	1	1	1
40. *Grewia tlliaefolia*	1	1	1	1

TABLE No. VI-B.2

COMPOSITION OF ACACIA CATECHU ANOGEISSUS LATIFOLIA ASSOCIATION

	Species	F	A	D	S
1.	*Acacia catechu*	5	5	4	2
2.	*Balanites roxburghii*	3	4	3	2
3.	*Boswellia serrata*	3	4	4	3
4.	*Cochlospermum gossypium* ..	3	3	3	2
5.	*Odina woodier*	3	3	2	2
6.	*Flacourtia ramontchi*	3	2	2	1
7.	*Zizyphus mouritiana*	3	3	3	1
8.	*Zizyphus oenoplia*	3	3	3	1
9.	*Diospyros melanoxylon*	3	2	3	2
10.	*Albizzia amara*	3	2	2	1
11.	*Soymida febrifuga*	3	2	2	1
12.	*Pongamia glabra*	3	2	1	1
13.	*Gymnosporia montana*	2	1	1	1
14.	*Acacia arabica*	3	2	2	2
15.	*Acacia leucophloea*	3	2	2	2
16.	*Azadirchta indica*	3	2	2	1
17.	*Mimosa hamata*	3	3	3	2
18.	*Acacia ferruginea*	3	3	2	2
19.	*Sterculia urens*	3	3	3	2
20.	*Mitragyna parvifolia*	2	1	1	1
21.	*Grewia pilosa*	2	1	1	1
22.	*Erythrina indica*	1	1	1	1
23.	*Dalbergia paniculata*	1	1	1	1
24.	*Anogeissus latifolia*	4	5	4	1
25.	*Garuga pinnata*	3	2	2	1
26.	*Euphorbia nerifolia*	1	1	1	1
27.	*Gmelina arborea*	1	1	1	1
28.	*Schrebera swietenioides*	..	..	..	..

A=Abundance ; D=Dominance ; F=Frequency ; S=Sociability

11. CONCLUDING REMARKS ON FLORA AND VEGETATION OF KHANDESH

Phytogeographical Considerations :

Majority of genera in central Satpudas in Khandesh are either Tropical or Subtropical, semi-green types or dry deciduous types. In central

Satpudas in Khandesh, they are not at all continuous but are confined to Raver ranges and to isolated tracts of forest in Akrani. In areas like Taloda and on Toranmal plateau only dry deciduous species are found. In them the sub-tropical elements are dominant. In older areas like Betul, Gavilgad, Mahadeo hills, tropical elements are seen here and there. In still younger areas near the coastal plains of Tapi in the vicinity of Surat, Dhadgaon plateau, Taloda, some tropical species are found localised. No endemics were noted. But plants like *Capparis decidua, Cassia auriculata, Clerodendron phlomoides, Helicteres isora, Vitex negundo* are localised at places. They gradually extend their limits. Many changes in climate have taken place due to rise of Himalayas, formation of Rajasthan desert and progressive desiccation of the North India in different geological areas. All these must have affected the climate of Khandesh, Vindhyas and Satpudas. The present day pattern of distribution, therefore, is the result of climate, soil and altered geological and geographical changes, possibly by the segregation of eco-types to suit semi-arid conditions. Many of course must have died in course of time.

The various elements that have entered the flora here are (1) Afro-Arabian, (2) Indo-Malayan, (3) Himalayan, and (4) Indo-gangetic.

12. Toranmal Hill and Crater Lake

Khandesh Satpudas extend geologically from Akrani taluka to Raver taluka. They are different than the Vindhyan-Satpudas in Madhya Pradesh, inasmuch as they are all derived from Deccan trap. The Toranmal hill constitutes a special feature of Khandesh. It is a tall hill surrounded by low hillocks 100′—150′ (30—45 Mtr.) in height. Similar flat tableland occurs on another hill tops, but they are very small at the north-west end of plateau. There is a precipitous ridge with a straight scarp 400 ′(121 Mtr.) in height. There is a lake at the centre of it from which the water falls in the valley and forms Sitakund of variable depth and shape. It bears an impression of a mighty convulsion of earth in the past. To the south of Toranmal hill near the lake there is a cave 12 sq. feet (4 Mtr.) in which there are some Jain temples and idols. The first throw of lake water down the valley is 243′ (73 Mtr.).

Toranmal is about 16 sq. miles (41 sq. km.) and its height is 3320′ (1009 Mtr.). There are ruins of old fortifications and walls of this lake. According to Dangerfield (1921) *Mem. Geo. Survey India*, Vol. 6, 1921 p. 107, it is an ancient crater lake. Toranmal plateau lies at 21° 52′ North latitude and 74° 34′ East longitude. Altitude on the eastern side of the lake is 3373′ (1031 Mtr.). It is the highest point of Toranmal plateau. The lake is 1.75 miles (2.70 km.) in circumference, 650 yards (594.360 Mtr.) in breadth. Its depth in the centre was found to be 134.5 feet. (40 Mtr). It is filled with rain water, by creating an artificial obstructure to the gorge between two small hills, like that for the Charlotte lake of Matheran. Rain water gets collected in it. There is also a smaller lake about 30′ a few hundred yards away from the larger crater lake. The overflow waters from both the lakes rush in the valley to Sitakund by a cascade ′400—500′ (121—152 Mtr.) deep, the fall being 243′ (73 Mtr.) straight. This is the largest summit of mountain in Khandesh. A hill station is being established there but by continuous erosion of the top lateritic soil gets washed off year by year. It needs to be conserved by plantation of some shrubs and trees, otherwise it will become very barren. Hot winds from the plains also visit the hill in summer.

There are dry deciduous plants like *Zizyphus rogosa* and *Phyllanthus emblica*. They predominate. It is quite likely that the hill may be reafforested if properly planted. The common tree species seen on it are : *Sterculia urens*, *Cochlospermum gossypium*, *Mitragyna parvifolia*, *Zizyphus jujuba*, *Z. oenoplea*, *Anogeissus latifolia*. Due to extreme cutting of tall trees *Latana camara*, *Vitex nigundo*, *Butea monosperma* have occupied the area.

13. ORIGIN OF SATPUDA FLORA

The exact geological period during which the Satpudas arose is not decided. The great amount of material derived from gneissic rocks is no doubt present in parts of eastern Satpudas in Betul and is similar to that in other parts of the Vindhyas. But the western Satpudas are basaltic in origin. The Satpudas in Mahadev hills are horizontally bedded sandstone or metamorphic rocks. They are quite different from the basaltic rocks in Khandesh of vulcanic origin. Transitional rocks are noticeable in the eastern Satpudas. The Mahadev hills are perhaps, like the Talchirs of lacustrine origin. Narmada valley in upper part is essentially of this type, but these Satpuda ranges join basaltic ranges in Tapi valley. The fossils in the Betul area, as well as the alluvial valley of Tapi are poorly known. Despite the two parts of Satpudas those belonging to Vindhyan series and those belonging to Deccan traps, they form a continuous chain of mountains.

A study of the plant elements in the Satpudas in Khandesh clearly indicates the presence of diverse elements such as Indo-Malayan, Afro-Persian-Arabic from Western Maharashtra. It is difficult to assume that they all have come at the same time. They must have come by different routes in different periods. For example, Indo-Arabic elements must have come by the Punjab, Sindh, Rajasthan desert route and diversified in flat Indo-Ganga plain and thence they might have come here. Similarly, Himalayan, Alpine plants now confined to high altitude also must have come by different routes in succession. Indo-Malayan plants which form a substantial part of the flora and vegetation of North-West Burma and of North-East region of India-Assam, must have come down through the Garo Rajmahal gap to Parasnath and thence into the Indo-Ganga plain and then they might have come right down to Vindhyas. From the Vindhyas they appear to have migrated by Satpuda trend to the Western ghats or the Sahyadris and continued to migrate southwards, till they found a suitable home where they could settle well climatically right down to Palneys and Kodai-Kanal hills which are an eastward extension of the western Ghats. There are many evidences to show that this has happened so. These have been marshalled together by Dr. Sunderlal Hora (1949) gathering evidences both from animal and plant distribution in the form of his well known "*The Satpuda Hypothesis*".

14. SATPUDA HYPOTHESIS (DR. S. L. HORA)

This hypothesis was formulated by Dr. S. L. Hora, the well-known Zoologist and Pisciculturist. It explains how the Malayan plants and animals have come to Peninsular India. For this, he suggested a highway for the immigration of animals and plants along the Satpuda trend of mountains. According to him the present day fishes found in Peninsular India such as *Bhavamia*, *Silurus*, *Thynnichthys* show Malayan affinities and are the products of rapid speciations. Some typical torrential fishes show discontinuous distribution from Yannan to the Eastern Hills of Assam bridging Garo-Rajmahal gap to Vindhyan-Satpudas,

thence to Deccan-Satpudas, and further down the Western ghats. This immigration of Himalayan fishes is supposed to have taken place not much before the Pliocene period when the climatic and physiographic and fluctuating conditions facilitated rapid speciation and migration. The present day fish isolate in Peninsular India persisted in some places, but today are far apart from each other, mostly in mountain ranges which provided favourable ecological conditions for their survival subsequently. Their distribution is discontinuous and restricted, probably as a result of disturbed orogenesis. The early streams in which they originally lived might have been captured by other streams. Similarly there are some molluscs like *Litholis* which are found at Cherapungi and in Maharashtra on mango trees in hilly regions.

The idea that the Malayan element is present in the flora and fauna of India was put forward by Clarke (1898) in his essay on the "*Sub-areas of British India*". According to him the different component elements were introduced in the flora of India, one after the other. For example, the sub-order Mapanieae of Cyperaceae belongs to the Eastern countries. *Hypolytrum* occurs in undisturbed continuity from Malaya to Sikkim. Apparently the various parts of Satpudas, Eastern and Western, have undergone physiographic changes right from Gondwana era to present day time. The Western Satpudas have hard grey trap rocks as its basic material in Akrani and Taloda, but it is soft amygdolidal trap in Shahada, Shirpur, Chopda and Yawal. The Satpudas in Mahadev hills are composed only partly of traps. It is believed that the river Narmada once upon a time joined the river Tapi in Khandesh. Consequently the lower part of Narmada valley underwent changes in the levels in the post-Tertiary periods. Different views are prevalent regarding deposits of Narmada alluvion. This altered the drainage conditions, produced many lakes joined to each other. These, of course, changed the flora and fauna.

The origin of Satpuda flora is thus due to diverse elements and changes of climate and terrain.

15. Economic Importance of Khandesh Forests

Khandesh forests in point of timber resources were once very valuable. The teakwood from Chopda, Yawal, Shahada, etc. was very famous locally. The yield has however dwindled in the last about 30 years. The dry scrub or thorn Savannah yields some important economic products such as gums, resins, cutch or *kath*, volatile or scented essential oil, bidi leaves, mohuwa flowers, etc.

A. *Gums and Resins* :

These are : (1) *Gum kadaya*—obtained from *Sterculia urens* used in textile industry and in confectionary, (2) Gum arabic—obtained from *Acacia arabica* etc., (3) Gum Ghati—obtained from *Anogeissus latifolia* often used as an adulterant in gum arabic, (4) Gum-resin of *Boswellia Serrata* sold in the market as '*Dhupa*'. Also a gum resin obtained from *Commiphora mukul* is sold being very scented and medicinal. It is known as Guggul and used in Ayurvedic preparations.

B. *Flowers of Mohuwa* :

Flowers of mohuwa or *Bassia latifolia* used as a cheap material in brewery, especially in Rum making.

C. *Kath or Cutch* :

This is mostly obtained from the heartwood of *Acacia catechu* and *A. suma*. It is used in Calico Printing Industry for printing *jajam* (cloth carpet) mainly in Jamner area of Jalgaon. It is used mainly in chewing betel-leaf.

D. *Bidi Leaves* :

These are now the monopoly of the State and a source of income to the Forest Department. It yields a revenue of Rs. 394.91 lacs or more to Maharashtra Government from *Tendu* or *Diospyros melanoxylon* Roxb.

E. *Essential Oil yielding grasses* :

Several grasses in India are odoriferous-*Cymbopogon martini* Watts.—Previously known as *Andropogon schoenanthus* var *Martini* Hook. f. is the best of them. It is known as *Rosha* grass or *T. khadi.* It is found growing all over India. It is abundant in Khandesh, Vidarbha, Nasik, Melghat, Betul, Panchgani etc. It has two varieties, not easily recognizable, *Motia* and *Sofia*. The latter forms distant patches but *Sofia* grows gregariously over large areas. Their oil at times is recognised as " Ginger oil ". It is extracted in Khandesh in crude stills by distilling. Green grass yields 0.3% oil with 50—60 % of moisture. Sun dried grass has less moisture 28 % but yield is more 1.25 %. *Sofia* grass gives better yield.

Rosha or Palm rosa oil is used in perfumery as a source of geraniol and is used in many essences and in medicine. It is exported to European countries, especially France. Bombay is the chief exporting centre in India.

Another species of *Cymbopogon nardus* Linn yields *Citronella* oil. It is mostly cultivated in Nilgiri hills of Madras, rarely in Maharashtra.

Indian *Rosha* oil has total 78—94% geraniol, free or combined. It is its main constituent. It is soluble in 3 volumes in 70% alcohol. Besides geraniol it contains a few other constituents. Oil prepared in Khandesh has 85% geraniol, but the one prepared in Melghat, Ellichpur, Burhanpur has 90—95% of geraniol oil. (For reference See *Wealth of India*. Vol. 11, pp. 416—418. CSIR Publication).

16. UNABDEV HOT WATER SPRING

At Unabdev near Chopda in Jalgaon district there is a remarkable hot water spring under Satpuda hills adjacent to an old temple of Murlidhar built about 200 years ago. The spring is laid by underground conduit into a square pond through a *gomukh* or cow's head made up of black stone. Hot water having temperature of about 140° F. gushes out of it into the pond. The algal flora of this place or the radio activity of the hot water in this spring have not been studied like those of *kunds* at Vajreshwari in Thane district or those near Chiplun.

Like Unabdev there are hot water springs at Sunabdev and Najhardev in Chopda taluka. Najhardev is about 3.2 km. from Sunabdev. All these springs flow through underground sources not traceable. The water temperature in these hot water springs varies from 85—103° F. in the morning. The water in them has slight sulphurous smell but it is less in Unabdev spring waters. The surrounding country of Satpuda is very hot where temperature reaches 113° F in summer.

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*N.B.—The lists of plants in the foregoing pages have been compiled with the help of references quoted below and the information supplied by Prof. M. R. Suxena, the late Prof. M. Syed-Ud-Din of Osmania University, Prof. K. B. Deshpande, Prof. S. T. Tilak, Dr. N. R. Rajderkar and staff of the Marathwada University, Aurangabad.

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SECTION C—FLORA OF VIDARBHA

CONTENTS

SECTION C—FLORA OF VIDARBHA

1. INTRODUCTION.

Vidarbha stands on an upland plateau having nearly 457-Z-548.6 metres elevation above M. S. L. It is a continuous stretch of land with black cotton soils derived from the Deccan Trap basalt. The plants on it are similar and also the flora. It lies in the valleys of Wardha, Vainganga, Katepurna and Purna rivers. Its eastern border however has different soils and also the rainfall pattern. The vegetation in general is of the dry deciduous type and semi-evergreen in certain places. There are also areas where only shrub is there as in Ahmednagar, Sholapur and Marathwada districts. For the most part, it is a kind of dry woodland Savannah. There is an admixture of a few evergreen a species with dry deciduous species as in Khandesh, particularly in Nagpur, Bhandara and Melghat areas. For example, *Tectona grandis* and *Gardenia lucida* grow with *Hardwickia binata* as in West Khandesh. But such situations are very few in the main forest belt of Western Maharashtra. Similarly in a number of places *Anogeissus latifolia* or *A. pendula* grow together with *Adina cordifolia.* The greatest part of Vidarbha flora in Amravati and other districts to the west of river Wardha is similar to that in Desh part of Maharashtra, but in Bhandara, to a certain extent in Nagpur; and much more in Chandrapur, one sees several elements growing together from the flora of Upper Gangetic plain, flora of Khandesh, flora of Bastar district in Madhya Pradesh, and from the flora of Orissa. This is probably because of the gaps in Satpuda mountains through which the plants of Vindhyan region have come down to Maharashtra. The dry deciduous elements in the forest are more or less common. Their abundance and growth however in different parts of it are not the same. For example, the trees of *Tectona grandis* growing in the valleys of Sahyadris are small in size, *e. g.,* on the slopes of Igatpuri ghat, Khandesh, and in Nagpur. But in Chandrapur they reach their optimum growth. There are different associations of *Tectona grandis* in which *Tectona grandis* grows well. It is the main timber species in all parts of Maharashtra including Chandrapur forests of Vidarbha.

As regards the general flora, there are hardly 50 to 60 species in the flora of Vidarbha which are different from those in the remaining Maharashtra,but there are many different herbs. The shrubs numbering about 50 are common ; but those in the ghat forests of Western Maharashtra are not seen in the flora of Vidarbha, *e. g., Gnetum ulva, Carvia callosa* various species of *Strobilanthes.*

2. LACK OF ENDEMIC ELEMENTS.

In the flora of Western Maharashtra there are at least 40 endemic or very rare species, but in the flora of Vidarbha no such endemic species, hardly a few, have been recorded. This shows that flora from the one end of Maharashtra to the other end right upto Guna, Indore and Jabalpur is of a similar nature. Only exception to this to a certain extent is the flora of Chandrapur. This is because of its contiguity with the districts from other States around it. It is the only area where Teak or *Tectona grandis* is self-sown. But it has no *Shorea robusta* belts, as are found in the forests of Bastar, Beladila, Jagadalpur areas, etc. This fact and dissimilarity of flora, are indicative of the ancient nature of flora in which *Shorea robusta* was widely spread in Peninsular India in the past. The very vigorous growth of *Tectona grandis* and other woody species as found in Vidarbha is not seen in other parts of Maharashtra.

A perusal of the list of plants in Nagpur, Ramtek, Melghat, Amravati and Chandrapur areas clearly shows that there is a large number of herbaceous species here, whereas in the flora of Western Maharashtra the shruby and woody species of *Strobilanthus*, *Carissa* and other shrubs are highly conspicuous. The shrubs on the top of ghats are rather sparse in the flora of Vidarbha. Though they are plentiful in a few areas. Their place in Melghat is taken by bamboos. The trap hills around Nagpur, Bhandara and other Vidarbha districts are covered in monsoons by herbaceous ground flora in a spectacular way, and even afterwards. In the semi-arid regions of Khandesh and Marathwada monsoon ephemeral flora constitutes a characteristic feature of the flora of the whole Maharashtra except Konkan. Throughout Peninsular India this is a grand sight after the rains, but they all die as soon as the temperature begins to rise in October and soils get depleted of moisture.

The Monsoon ephemeral flora is characteristic of Andhra Pradesh, Madhya Pradesh and Maharashtra, *i.e.*, of the plateau of Peninsular India.

Flora in the Narmada basin is also characteristic, but it contains elements both dry and moist woody species, and some monsoon ephemeral plants in the lower part of the Narmada basin.

In point of economy of the Maharashtra State, the forests in Chandrapur district of Vidarbha are the most important, since the rich forests of Dangs have been conceded to Gujarat. They are also a part of the Deccan tableland. Various plant products are obtained from Chandrapur.

There is scope for further exploitation and exploration of them. A number of places in Vidarbha such as Warora, Naduri Budruk etc. are heavy coal mining areas below the forests which on the surface look so unpromising, but there is coal. At Ballarshah there is a paper mill and many wood saw mills. However no attempt seems to have been made for the introduction of new woody species that could thrive here, particularly from the forests in the foot hills of Siwalik Himalayas where similar dry deciduous forests do occur. It is very likely that some pines from the Caribean Sea Islands and plants like *Englehardtia*, desert species of *Acacia* and *Eucalyptus* from Australia will grow well here.

3. Citrus Fruit Cultivation in Nagpur Region.

The rivers in Vidarbha as a rule are shallow, flowing as they do through hard Deccan Trap rocks. Naturally they do not have much alluvium, but the soils around Nagpur right upto Sausar, alternation of very cold climate in winter followed by hot summer, enough humidity, are very favourable for the plantation of *Citrus fruit* trees. Nagpur is famous all over India for citrus fruits. Here they generally do not fall a prey to the severe Die Back disease of Citrus, as do the plants in Rahuri area in Ahmednagar district.

4. Climate of Vidarbha Districts.

Vidarbha comprises eight districts (1979-80), Buldhana, Yeotmal, Akola, Amravati, Wardha, Nagpur, Bhandara and Chandrapur.[1] Of these, the climate of seven districts except Chandrapur is somewhat similar. The northern and western parts of Vidarbha are climatically similar, but the eastern and southern parts of Bhandara and Chandrapur are rather different. The climate is hot and dry in the seven districts mentioned above, as they are a continuation of Marathwada and Desh part of Western Maharashtra.

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1. Gadhachiroli has subsequently been constituted into a separate district.

District Buldhana :

This district has hot summer and well distributed rainfall due to South-West Monsoons. It is generally dry in winter from December to February, and hot in summer—March to June. The average rain-fall is 796 mm. It is more towards south than towards north. Buldhana, Dhamangaon area at the north-west gets more rainfall. July is the rainiest. The number of rainy days is 47. October to November is post-monsoon period and it also brings some rain. The annual mean temperature is 38.3°C (100.9°F). In May, the maximum temperature goes upto 43.3°C (109.8°F). The daily minimum is 27.4 °C or 81.30°F. In summer the heat is very severe, reaching sometimes 116.6°F or 47°C in the northern part. Humidity in monsoons is high but in the rest of the year, it is dry. A special feature of the climate here are the monsoon depressions arising from the cyclones in the Bay of Bengal and moving westwards with very widespread heavy rains. The post-monsoon storms and depressions from the Bay of Bengal affect the weather.

District Yeotmal :

The climate of this district on the whole is hot and dry. There are rains from June to October and also in the post-monsoon period in November. Annual rainfall due to S. W. monsoon for the whole district is 991·6 mm. It increases from north-west to south-east. Near the northern border town of the district has 896.3 mm. rain. South-east border town of Pandharkavda gets 1122.2 mm. rain. Variation in the rainfall from year to year is large. In about 50 years the rainfall is subnormal once or twice.

The mean daily maximum temperature at Yeotmal is 41.8°C (107.2°F) and the mean daily minimum temperature is 28.3°C (82.9°F). In summer the heat is intense, the maximum temperature goes to 47°C (116.6°F). December is the coldest month, daily minimum temperature reaching 15.1°C (59.2°F) ; maximum is 28.4°C (83.1°F). Western disturbances from the sea and north India set up cold waves which affect the district. Summer months are very dry. Other months except rainy season are also dry. Depressions in the Bay of Bengal cross the district at any time. S. W. Monsoon is highly speedy. Gusty winds generally blow in October and November.

District Akola :

Akola is the hottest and driest district of Vidarbha. The average annual rainfall for it is 846.5 mm. It increases from north-west to south-west and varies from 767.3 mm. at Telhara on the north-west border to 926.8 mm. at Washim on the south-east border. Annual rainfall for the district is 600—1100 mm. Once or twice in fifty years, it is much less. The number of rainy days is 48. Daily temperatures are very high and heat is intense in summer ; but nights are cool even in April. The day temperature goes upto 46-47°C (114.8°-116.6°F). Thunder storms are not unusual in summer. There is a secondary maximum temperature rise during day time in October. The temperature rises rapidly after February. The highest maximum temperature recorded at Akola is 47.8° C (118°F) on May 22, 1947. Its peculiarity is that it lasts for more than 12—14 hours during a day here. Monsoon depressions originating in the Bay of Bengal move westwards bringing stormy winds and wide spread rainod ui sst-monsoon months.

District Amravati :

There is dryness in the air throughout except during monsoons. The average rainfall for the district is 887.4 mm. in the plains. Rainfall in the hills like Chikhaldara is generally twice as much as this. July is the rainiest. The number of rainy days in plains is 49, but at Chikhaldara they are 77. Mean daily maximum temperature at Amravati is 28.6°C (83.2°F) and the mean daily minimum 15.1°C. At Chikhaldara the maximum and minimum are 22°C (72°F) and 13°C (55°F) respectively. Westerly disturbances from North India, and cold waves affect the district. Then the temperature goes down to 5°C but begins to rise rapidly from February.

District Wardha :

The climate here is like that of adjoining districts hot and dry. Average annual rainfall for the district is 1090.3 mm. Rains last from June to September. July is the rainiest. The number of rainy days is 56. May is the hottest month and December the coldest. Daily maximum temperature goes upto about 42.0°C (107.6°F) and daily minimum is about 28°C (82.4°F). But in certain places daily temperatures could be higher than the average. In summer especially they rise to 47°C (116.6°F). Heat in summer is severe but the nights are cooler. After June there are thunder storms which bring down the temperature. Western air disturbances and cold waves from North India affect weather bringing very cold winds when the night temperature goes down to 5°C (41°F).

District Nagpur :

Summer is very hot and weather dry. The average annual rainfall in the district is 1161.7 mm. It is well distributed increasing from west to east. It is highest in July. 90 percent of it comes in June to September. The number of rainy days is 59. November and December are cold months. December is the coldest. Daily maximum temperature is 28.7°C (83.6°F). May is the hottest month when the mean maximum temperature goes to 42.7°C (108.8°F). Nights are relatively cool. The thunder storms begin to increase with the beginning of monsoons in the second week of June and the heat goes down. The minimum temperature in winter can be as low as 4°C (39°F). Winds are moderate.

District Bhandara :

The summer is very hot and dry. The annual rainfall is 1470.6 mm. It increases from West to East. It is very variable, 1312.9 mm. at Chandpur, to 1578.5 mm. at Gondia towards the places at the north-east end of the district. They begin in the second week of June, July and August have heavy rains. Once in 4—10 years the rainfall is less or more once or twice. However, it is well distributed. The number of rainy days is 63.

The mean maximum temperature for the district is 27.7°C (81.9°F). The mean daily minimum is 13.1°C (55.6°F). The minimum temperature sometimes goes down to 7°C (44.6°F). May is the hottest month. December, January are the coldest. In May the maximum temperature rises as high as 42.1°C (107.8°F). Thunder storms are common in summer. The rainfall is mostly due to S. W. monsoons, some to N. W. monsoons. Winds begin to blow from south-west to north-west during monsoons, and in the riverse direction in the post-monsoon period.

The thunder storms are common in June and also towards the end of monsoons. The disturbances from the Bay of Bengal cross the district and affect the weather.

District Chandrapur :

The district is quite hot in summer, and there is general dryness in other months, but not in monsoons. The rainfall is due to S. W. monsoons and also due to return monsoons and from the Bay of Bengal. It is well distributed. The average annual rainfall for the district is 1420 mm. It increases from west to east and varies from 1184.8 mm. at Warora to 1826.5 mm. at Murumgaon. The number of rainy days is 63. December is the coldest month, when the temperature goes to 28-2°C (82.8°F). The mean daily minimum temperature is 11.6°C (52.9°F). Daily mean maximum temperature in the Southern half of the district is 29.8°C. It rises rapidly after February, and May is the hottest month of the year. In May the mean daily maximum temperature rises to 43°C (109°F), and the minimum to 28.9°C (82.4°F). Summer is intense. Occasionally the temperature rises to 48°C (118°F). There is a secondary peak rise in temperature in October. In December temperatures fall rapidly. The highest temperature at Chandrapur was noticed in May 1912 to be 118.9°F or 48.6°C. At Sironcha also the temperature rises very high in May to 46.7°C (116.1°F), which in December comes down as low as 2.8°C (37°F) and weather becomes very cold. At Chandrapur they go down to 7.8°C (48°F). Other places have similar temperatures. Humidity during monsoons S. W. and N.E. is pretty high, even in the post-monsoon period. Thunder storms occur in all weather. In December the temperature at Chandrapur is 27.2°C (80.9°F). The daily maximum temperature 94°F and minimum 93°F or 23°C. The heat is very severe in May, but the nights are much cooler. In the late May and in June there are thunder storms. They are due to depressions coming over from the Bay of Bengal and crossing the district.

5. Flora and Vegetation of Vidarbha.

Works on the flora of Vidarbha as a whole, are practically nil and there is no authoritative text on the flora. So far, only some lists of plants in different parts of Vidarbha are available and stray references to them in literature. As early as 1887 Van Somaran had published "A list of trees in Melghat Forest" giving account of 110 trees. Diackon had prepared "A list of species in Berar Circle" followed by "A list of trees, shrubs and climbers in the northern circle of Central Provinces". But none of these are available, not being published. Utilising these Witt (1908) prepared a more comprehensive "List of trees, shrubs, climbers and other plants of economic importance found in Berar Circle of the (then) Central Provinces", about 266. A descriptive list of trees, shrubs and economic herbs of Southern Circle of the Central Provinces was made by Graham (1911) particularly of Nagpur Plants, about 309, and another by Haines (1916). These were the only authoritative lists. Recently, however, R. I. Patel (1964) has published a book on "*The Forest Flora of Melghat*" which is really a junction of several ghat areas around. It should be considered as representative of the plants in the hilly areas and ghats in Vidarbha, their slopes and nearby plains. Patel (1964) has given an account of the trees and shrubs belonging to 716 species of angiosperms spread over 86 families, and of 7 introduced species of conifers in Melghats which is an important forest region of Vidarbha. Balapure (1966) has been working on Nag-Vidarbha, Ramtek flora. He estimated about 2000 plants in old Central Province.

The hill station of Chikhaldara lies in the Melghat area and the Project Tiger Sanctuary of Kolkaz is near Chikhaldara. These may be taken fairly representing the flora an‿ vegetation in the plains, hills and valleys in Vidarbha. Recently Malhotra and Moorthy (1971) have described species in Chandrapur District. It is obvious that the flora here is very rich containing dry deciduous, semi-evergreen and some moist evergreen species. The well known tiger and wild game Reserve, *Tadoba* Sanctuary, lies in Chandrapur. According to Balapure (1966) there are at least 2000 plants in Vidarbha. Special features of Chandrapur are six Forest Divisions in the single District of Chandrapur. The teak (*Tectona grandis*) and other timber species grow here very luxuriantly and yield highest revenue to the State. The growth of timber trees here is very luxuriant as can be seen from the statement below. In Chandrapur *Tectona grandis* grows to 114—140′. Elsewhere *Tectona grandis* (Teak) grows only about 50—60′ in height, *e. g.*, in Nasik, Dangs and Khandesh forests. In North Kanara it grows to 70′.

6. Growth of Different Timber Trees in Allapalli Forest Reserve, Chandrapur District (as given by Chadras, 1962).

	Name	Height (in feet)	Girth (in feet)
1.	*Tectona grandis*	141	13
2.	*Tectona grandis*	136	6-7
3.	*T. grandis*	116	8-11
4.	*T. grandis*	115	11-9
5.	*Adina cordifolia*	115	10-3
6.	*Tectona grandis*	114	17
7.	*T. grandis*	114	11-10½
8.	*T. grandis*	113	14
9.	*T. grandis*	113	13-10
10.	*T. grandis*	113	12-7
11.	*Stephegyne parviflora*	91	13

On the whole the vegetation in Vidarbha is of the dry or mixed deciduous type in which *Tectona grandis* predominates. The vegetation however changes and assumes different facies according to location, topography, soils altitude, rainfall, humidity etc. in different months of the year.

7. Plants of Melghat.

The list of plants in Melghat is given on pages 376-87. The main hill station in Vidarbha is that of Chikhaldara. It lies at the south-east end of Vidarbha. It is 10 km. in extent where *Ougenia oojeinensis* Linn. *Emblica officinalis* Gaertn. *Terminalia chebula* Retz, *Syzygium cumini* (L) *Skeels*, *Ficus glomerata* Roxb. *Careya arborea* Roxb., *Mangifera indica* Linn. and *Zizyphus rugosa* Lamk. grow. The canopy is formed mainly by *Ougenia oojeinensis*, *Zizyphus xylopyra* Willd. *Wrightia tinctoria* Br. form second layer. Small shrubs grow here and there.

In the drier parts *Anogeissus latifolia* Wall, *Dalbergia paniculata* Roxb. *Butea monosperma* (Lamk) Jaub. *Hardwickia binata* Roxb., *Tectona grandis* Linn., *Sterculia urens* Roxb., and *Acacia* sps. occur. Mostly these are secondary species. Undergrowth is of grasses like *Schima sulcatus* (Hack.) A. Kamas., *Apluda mutica* and *Symbopogon martini* (Roxb.) Watg. Bamboos cover large tracks of slopes in drier areas. They are *Dendrocalamus strictus*, and in valleys, *Bambusa nana*. *Lantana camara* occupies large tracks of forest lands, and forms dense thickets. The other associates of it are : *Helicteres isora* (Vaghl.) *R., Nyctanthes arbor tristis* Linn, *Pogostemon pletranthoides* (Vahl.) R. Br. and *Vitex negundo*. Ten dominant families in the Melghat area are :—

		Genera	Wild species—	+	Cultivated
1.	Leguminoceae	24	53	+	7
2.	Acanthaceae	12	20	+	8
3.	Rubiaceae	20	24	+	1
4.	Malvaceae	9	21		
5.	Verbenaceae	10	16	+	6
6.	Apocynaceae	11	10	+	3
7.	Caesalpinaceae	7	20	+	2
8.	Compositae	7	10	+	7
9.	Asclepiadaceae	7	8		
10.	Rhamnaceae	7	8		

The list of plants in Melghat clearly indicates the dry deciduous nature of vegetation similar to that in other parts of Maharashtra. It is in no way different from it in the composition, but *Tectona grandis* is often mixed with *Hardwickia binata* and *Adina cordifolia*. The former is indicative of dry habitats. The plants of Nagpur, Ramtek and around are like those of many other semi-arid places in Maharashtra, but because of higher rainfall there are many ponds in this region, some permanent and some temporary, drying after monsoons.

Flora of Melghat

(After R. T. Patel, 1968)

Name	Flowering season
1. Ranunculaceae	
Clematis triloba Heyne	October-November
2. Dilleniaceae	
Dillenia indica Linn.	June-July
(*Dillenia pentagyna* Roxb.) ..	April—Sept.
3. Magnoliaceae	
Michelia champaca Linn. ..	April—September
Anonaceae :	
Anona squamosa Linn.	May—July
Miliusa velutina H. and T. ..	March—May
(*M. tomentosa* (Roxb.) Sinclair)..	May-June

Name	Flowering season
Menispermaceae :	
Cissampelos pareira Linn. ..	July—October
Cocculus hirsutus Desl.	November—February
Tinospora cordifolia Miers ..	April
Papaveraceae :	
Argemone mexicana Linn. ..	Throughout the year (weed).
Capparidaceae :	
Gynandropsis gynandra (Brig.) ..	December—April
(*Crataeva religiosa* Forst.) ..	March—May
Maerua arenaria Hook. f. and Thomas.	Cold season
Capparis spinosa Linn.	February —June
C. grandis Linn.	April—October
Bixaceae :	
Cochlospermum religiosum Linn.	January –April
Flacourtia indica (Burm. f.) Merr.	January—March
Portulacaceae :	
Portulaca oleracea Linn.	October—December
Tamaricaceae :	
Tamarix gallica Linn.	November—February
(*T. dioica* Roxb.)	November—February
T. ericoides Rottl.	November—February
Malvaceae :	
Malvastrum coromandelianum Garcke.	September
Sida veronicaefolia Lamk. ..	September—November
S. glutinosa Cav.	August—December
S. spinosa Linn.	August—October
S. acuta Burm.	August—December
S. rhombifolia Linn.	July—September
S. cordifolia Linn.	August—October
Abutilon indicum Sw.	September—November
A. glaucum (Cav.) Sw.	September—November
A. graveolens Wight and Am. ..	September—December
Urena lobata Linn.	August—November
(U. sinuata Linn.)	September—November
U. repanda Linn.	October-November
Hibiscus ficulneus Linn.	September—November
H. micranthus Linn.	October-November
H. esculentus Linn.	
H. cannabinus Linn.	October—November
Abelmoschus micranthus Linn. ..	October—November
Abelmoschus manihot Linn. Medik.	September—October
Kydia calycina Roxb.	August—November
Salmalia malabarica (DC) Sch. and Endl.	February—March
Sterculiaceae :	
Sterculia urens Roxb.	December—February
S. villosa Roxb.	March—April

Name	Flowering season
Firmiana colorata R. Br.	March—April
Helicteres isoza Linn.	June—December
Eriolaena hookeriana W. and A...	March—July
Tiliaceae :	
Grewia orbiculata Rottl.	April
Grewia damine Gaertn.	July-August
G. tiliaefolia Vahl...	May—July
G. asiatica Linn.	March—May
G. flavescens Jun.	August—October
G. hirsuta Vahl.	July—September
G. abutifolia Vent. ex Jun. ..	June-July
Triumfetta rhomboidea Jacq. ..	August—December
T. rotundifolia Lam.	August—December
T. pilosa Roth.	September-October
Corchorus olitorus Linn.	
Zygophyllaceae :	
Tribulus terrestris Linn.	Throughout the year
Rutaceae :	
Feronia limonia (Linn.) Swingle	February—May
Aegle marmelos Correa	April—June
Murraya paniculata (Linn.) Jack.	May—September
Murraya koenigii (Linn.) Spr. ..	March—April
Simarubaceae :	
Ailanthus excelsa Roxb.	February-March
Balanites aegyptica Linn. Delile ..	March—May
Bursaraceae :	
Boswellia serrata Roxb.	January—April
Garuga pinnata Roxb.	February—April
Commiphora wightii (Arn.) Bhandari.	February—April
Meliaceae :	
Melia azadarach Linn.	March—May
Azadirachta indica A. Juss. ..	March—May
Soymida fibrifuga A. Juss. ..	March-April
Cedrela toona Roxb.	March-April
Chloroxylon swietenia DC ..	March-April
Olacaceae :	
Olax scandens Roxb.	April—June
Cansjera rheedii Juss.	November-December
Celastraceae :	
Celastrus paniculata Willd. ..	April—June
Gymnosporia spinosa (Forsk) Fiori.	October-November
Elaeodendron glaucum Pers.	
Rhamnaceae :	
Ventilago calyculata Tul.	Winter
Zizyphus oenoplia Mill.	August—September
Z. mauritiana Lamk.	September—November
Z. nummularia W. and A. ..	March—June

Name	Flowering season
Z. rugosa Lam	April-May
Z. xylopyra Willd.	January—April
Helinus lanceolatus Brand ..	January—April
Ampelidaceae :	
Leea macrophylla Roxb.	July—October
Leea edgeworthii Santapau ..	July—September
Ampelocissus latifolia (Roxb.) Planch.	
Cissus quadrangularis Linn. ..	July—September
Cissus repanda Vahl.	April-May
C. setosa Roxb.	July-August
Cayratia carnosa Gagnep. .. (*Cayratia auriculata* (DC) Gam.)	July-August
Sapindaceae :	
Cardiospermum halicabum Linn.	September—November
Schleichera oleosa (Lour.) Olkeen	August-September
Sapindus laurifolius Vahl. ..	October—December
S. emarginatus Vahl.	October—December
Dodonaea viscosa Linn.	Monsoon
Anacardiaceae :	
Semecarpus anacardium Linn. ..	
Mangifera indica Linn.	February—May
Anacardium Occidentale Linn. ..	
Buch anania lanzan Spreng. ..	January—March
B. angustifolia Roxb.	January—July
Spondias mangifera Willd. ..	February—April
Moringaceae :	
Moringa oleifera Lamk.	January—April
Leguminosae :	
Heylandia latebrosa DC	August
Crotolaria mysorensis Roth. ..	September
C. chinensis Linn.	September
C. sericea Retz.	October—March
C. verrucosa Linn...	October—February
C. juncea Linn.	Cold season
Indigofera linefolia Retz.	July—September
Indigofera cordifolia Heyne ..	August—December
I. denneaphylla Linn.	October-November
T. trifoliata Linn.	August—October
I. trita Linn.	
I. glabra Linn.	September-October
I. tinctoria Linn.	August-September
I. hirsuta Linn.	August—September
I. cassioides Rottl. ..	December-January
Millettia auriculata Baker. ..	April—June
Tephrosia purpurea Pers.	September—November
Sesbania bispinosa (Jacq.) Fawette and Rendl.	October—December.
S. sesban Linn.	September—November
S. grandiflora Pers.	All various times
Aeschynomene indica Linn. ..	August—September

Name	Flowering season
Uraria picta Desv.	August-September
Alysicarpus vaginalis Linn. ..	September-October
Ouginia oojeinensis (Roxb.) Hooker	Feb—May
Desmodium cephalotes Wall. ..	
Desmodium laxiflorum DC. ..	Aug—Sept.
D. triflorum Linn. ..	Sept—Oct.
D. gangeticum DC ..	July—Sept.
Desmodium latifolium DC. ..	Aug—Sept.
D. motorium (Houtt.) Merr. ..	Aug—Sept.
Abrus precatorius Linn. ..	Aug—Sept—Oct.
Mucuna prurita Hook. ..	Sept—Nov.
Erythrina variegata (Linn.) Var. *orientales* (Linn.) Merr.	
Erythrina suberosa Roxb. ..	
Butea parviflora Roxb.	Cold season
B. monosperma (Lamk.) Taub.	
B. superba Roxb.	
Pueraria tubersoa DC.	Cold season
Atylosia scarabaeoides Benth. ..	June—October
Cylista scariosa Roxb.	November—February
Rhynchosia albiflora (Sims.) Alston.	October—December
R. minima DC.	September—December
Moghamia strobilifera (Linn.) St. Hil.	October—December
M. bracteata Roxb.	August—November
M. lineata (Roxb.) St. Hil ..	November—January
M. involucrata (Benth.) St. Hil. ..	October—December
Dalbergia sisoo Roxb.	March—June
D. latifolia Roxb.	January—February
D. paniculata Roxb.	April—June
D. lanceolaria Linn.	April-May
D. volubilis Roxb.	February—March
Pterocarpus marsupium Roxb. ..	May—June
Pongamia pinnata (Linn.) Pierre	April—June
Sub-Family Caesalpineae :	
Caesalpinia bonducella (Linn.) Roxb.	July—September
C. separia Roxb.	February—May
C. pulcherrima Sw.	June—March
Delonix elata (Linn.) Gamble ..	June—September
D. regia (Bog.) Raf.	April—June
Parkinsonia culeata Linn. ..	October—April.
Cassia fistula Linn.	March—June
C. siamea Lamk.	August—May
C. occidentalis Linn.	September—November
C. sophera Linn.	August—December
C. obtusifolia Linn.	September—December
C. auriculata Linn.	October—March
Harwickia binata Cor	October-January
Tamarindus indica Linn.	May-June
Bauhinia racemosa Lamk. ..	March—June
B. malabarica Roxb.	Common throughout
B. retusa Han.	September—December
B. purpurea Linn.	September—November
B. variegata Linn.	February—April
B. vahlii W. and A.	February—June

Name	Flowering season
Sub-Family Mimosae :	
Prosopis spicigera Linn.	February—April (Found on the border of Melghat).
Dichrostachys cinerea W. & A. ..	September—December
Mimosa hamata Willd.	August—October
M. rubicaulis Lamk.	August—October
Acacia arabica (Lamk.) Willd ..	August—December
A. farnesiana Willd.	August—March
A. leucophloea Willd.	August—November
A. jacquemonti Benth.	February—April
A. catechu Willd.	August—October
A. ferruginia DC.	January—April
A. lenticularis Buch. Ham. ..	April-May
A. rugata Lamk.	March—July
A. torta Roxb.	May—September
A. pinnata Linn.	July—September
Albizzia lebbeck Linn.	March—May
A. odoratissima (Linn.) Benth. ..	April—June
A. procera (Roxb.) Benth. ..	May—June
Rosaceae No wild plant, all cultivated.	
Crassulaceae :	
Bryophyllum calycinum Salsb. ..	June
Combretaceae	
Terminalia chebula Retz.	April-May
T. bellerica Gaertn.	February—May
T. arjuna W. & A.	April-May
Anogeissus latifolia Wall.	May—July
A. pendula Edgew.	May-June
Combretum ovalifolium Roxb. ..	January—March
C. decandrum Roxb.	February-March
Calycopteris floribunda Roxb. ..	December—March
Myrtaceae :	
Syzygium cuminil (Linn.) Skeels.	May-June
Syzygium salicifolium Grah. ..	March—June
Careya arborea Roxb.	March-April
Lythraceae :	
Woodfordia fruiticosa (Linn.) Kurz.	January—April
Lawsonia inermis Linn.	
Lagerstroemia parviflora Roxb. ..	March—July
Onagraceae :	
Jussiaea subfruticosa Linn. ..	August—October
J. perensis (Linn.) Brenan ..	May-June
Samydaceae :	
Casearia graveolens Dalz. ..	May-June
C. elliptica Willd.	February—May
Caricaceae :	
Carica papaya Linn.	Cultivated

Name	Flowering season
Cucurbitaceae :	
Trichosanthes palmata Roxb.	Monsoon
Cactaceae :	
Opuntia elator Mill.	
Cornaceae :	
Alangium salvifolium (Linn.) Wang.	February—April
Rubiaceae :	
Anthocephalus indicus A. Rich.	May—July
Adina cordifolia (Roxb.) Book.	June—September
Mitragyna parvifolia (Roxb.) Korth.	May-June
Wendlandia excelsa (Roxb.) DC.	February—April
Oldenlandia corymbosa Linn.	September—November
Mussaenda frondosa Linn.	July—October
Randia ulinigosa DC.	May—July
R. brandisii Gamble	March—June
Gardenia gummifera Linn.	
G. resinifera Roth.	March—July
G. latifolia Ait.	March—May
Knoxia summatrensis (Retz.) DC.	August—November
Meyenia laxiflora Robyns.	February—May
Canthium parviflorum Lamk.	April—June
Ixora arborea Roxb.	March—May
Pavetta indica Linn.	
Coffea arabica Linn.	Introduced.
Morinda tinctoria Roxb.	
Chasalia curviflora Thw.	
Hamiltonia suaveolens Roxb.	
Borea stricta (Linn.) Schum.	
Rubia cordifolia Linn.	
Compositae :	
Vernonia cinerea Linn.	
V. divergens (Roxb.) Edg.	November—January
Adenostemma lavenia (Linn.) Kuntze.	September—November
Ageratum conyzoides Linn.	November—January
Cyathocline purpurea (Don.) Kuntze.	November—January
Artemisia parviflora B. Ham.	October—December
A. vulgaris Linn.	August—December
Blumea obliquea (Rinn.) Druce	October—December
B. membranacea DC.	March—May
Xanthium strumarium Linn.	August—October
Plumbaginaceae :	
Plumbago zeylanica Linn.	July—September
Myrsinaceae :	
Maesa indica Wall.	December—March
Embelia ribes Burm.	February
E. tsjeriam. cottam (R and S.) DC	April—July

Name	Flowering season
Sapotaceae :	
Madhuca indica Gmel. ..	March-April
Manilkara hexandra (Roxb.) Dub.	October-November
Ebenaceae :	
Diospyros melanoxylon Roxb. ..	February—April
D. montana Roxb.	March—May
D. chloroxylon Roxb.	July—September
D. emdryopterts Pers.	March—May
Oleaceae :	
Jasminum sambac Ait	July—September
J. multifltorum (Burm.) F. Andr.	Cultivated in Monsoon
J. arboreascens Roxb.	April-May
J. officinale Linn.	May—July
J. grandiflorum Linn.	March—August
Nyctanthes arbor-tristis Linn. ..	August—October
Schrebera swietenioides Roxb. ..	August—October
Apocynaceae :	
Carissa spinarum A. DC ..	March—May
C. carandas Linn.	January—April
Rauwolfia serpentina Linn. ..	November-December
Tabernaemontanadivaricata (Linn.) R. Br.	May—August
Plumeria rubra Sant. & Irani ..	Cultivated in rainy season
Holarrhena antidysenterica Wall.	March—June
Wrightia tomentosa Roem. ..	April June
W. tinctoria R. Br.	March and April
Icnocarpus frutescens Ait. ..	September—December
Vallaris solanaces Roxb.	November—April
Asclepiadaceae :	
Hemidesmus indicus (Linn.) R. Br.	August-September
Cryptolepis buchanani Roem. ..	May—June
Calotropis gigantea (Linn) R. Br.	November—July
C. procera (Linn.) R. Br. ..	Chiefly in cold season.
Holostemma annularis (Roxb.) K. Schum.	July—September
Pergularia daemia (Forsk.) Chiov.	August—January
Marsdenia volubilis (Linn.) Cooke	April—July
Leptadenia reticulata W. and A.	April-July.
Loganiaceae :	
Buddleia asiatica Lour.	December-February.
Strychnos potatorum Linn. ..	April-May.
Boraginaceae :	
Cordia dichotoma Forst.	January-March.
Cordia macleodii Hook.	March-May.
Ehretia laevis Roxb.	February-March.
Rhabdia lycoides Mart	
Convolvulaceae :	
Cuscuta reflexa Roxb.	December-January.
Rivea ornata Chois.	August-September.
R. hypacrateriform i. Chois. ..	August-September.

Name	Flowering season
Jacquemontia paniculata (Burm.) Hall.	October-November.
Argyreia sericea Dab.	August-September.
A. strigosa (Roth.) Santapau & Patel.	October-December.
Ipomoea tropica Santapau & Patel	October-November.
I.maxima (Linn. f) Don. ex Sweet	August-October.
I.pes-tigridis Linn	September-November
Solanaceae :	
Solanum xanthocarpum Schred and Wendl.	June.
S.indicum Linn	August-October.
Physalis peruviana Linn.	
Withania somnifera Dunal. ..	August-September.
Datura stramonium Linn... ..	September-December.
D.metel Linn.	Rainy season.
Scrophulariaceae : No wild plants.	
Bignoniaceae :	
Oroxylum indicum (Linn.) Vent...	May-July.
Dolichadrone crispa Seem. ..	March-May.
D. falcata Seem	March-May.
Heterophragma quadriculare(Roxb. K. Schm.)	February-April.
Stereospermum personatum (Hassk.) Chatterjee.	March-May.
S.suaveolens DC	March-May.
Radermachera xylocarpa (Roxb.) L. Schum.	April-May.
Pedaliaceae :	
Martynia annua Linn.	August-September.
Acanthaceae :	
Hygrophila auriculata (Schum.) Heire.	October-January.
Blepharis maderaspatensis (Linn.) Heyne ex Roth.	October-December.
Petalidium barlerioides(Roth.)Nees.	February-April.
Carvia callosa (*Wall.*) Bremck. ..	
Lepidagathis cuspidata(Wall.) Nees	Feb-April.
Eranthemum purpurascens Nees. ..	November-January.
E.roseum (Vahl.) R. Br.	November-January.
Barleria boerhaaviaefolia Pers. ..	December-February.
B.prionitis Linn.	October-January.
B.cristata Linn.	September-December.
B.strigosa Willd.	
Rungia repens (Linn) Nees. ..	October-January.
Justicia betonica Linn.	September-January.
J. quinqueangularis Keen	
J. simplex D. Don	November-September.
Adhatoda vasica Nees	August-December.
Rhinacanthus nasuta (Linn.) Kurz.	October-January.
Thunbergia alata Boi.	Cultivated.
T. fragrans Roxb	
T. grandiflora Roxb.	
T.laurifolia Lindl.	
Thunbergia coccinea Wall ..	

Name	Flowering season
Verbanaceae :	
Lantana camara Linn.	July-September
Stachytarpheta mutabilis Vahl. ..	Rainy season.
Tectona grandis Linn.	August-September.
Gmelina arborea Roxb.	March-May.
Premna flavescens Ham.	March-May.
P.barbata Wall.	April-June.
Vitex negundo Linn.	June-December.
V.trifolia Linn.	June-December.
V.leucoxylon Linn.	March-August.
Clerodendron phlomidis Linn. ..	September-February.
C.serratum (Linn.) Moon. ..	August-November.
V.viscosum Vent.	February-May.
Holmskioldia sanguinea Retz. ..	October-December.
Symphorema polyandrum Wight...	February-April
Duranta repens Linn.	
Labiateae :	
Plectranthus rugosus Wall. ..	September-November.
Colebrookea oppositifolia Smith...	December-February.
Pogostemon plectranthoides Desf.	December-February.
Nyctaginaceae :	
Boerhaavia diffusa Linn.	October-December.
B.repanda Willd.	
Amarantaceae :	
Celosia argentea Linn.	September-October.
Aerua sanguinolenta (Linn.) Bluem.	Cold season.
Achyranthes aspera Linn. ..	November-January.
Chenopodiaceae :	
Beta vulgaris Linn.	Cultivated.
Polygonaceae (No wild plants) :	
Antigonon leptopus H. and A. ..	Garden plant, August-December.
Lauraceae :	
Litsea glutinosa (Lour.) Robinson	June-July.
L.monopetala (Roxb.) Pers. ..	March-May.
Loranthaceae :	
Viscum articulatum Burm ..	January-August.
Macrosolen parasiticum Linn. ..	
Scurrula parasatica Linn	October-February.
Dendrophthoe falcata (Linn.) Etting.	February-June.
Santalaceae :	
Santalum album Linn.	March-April.
Osyris wightiana Wall. ex Wight.	March-April.
Euphorbiaceae :	
Euphorbia neriifolia	February-March
E. nivulia Ham.	February—April
E. tirucalli Linn.	August-September
E. pulcherrima Willd.	

Name	Flowering season
Moraceae :	
Ficus religiosa Linn.	April—June
F. arnottiana Miq...	March—June
F. lacor Buch. Ham	April—June
F. tsiela Roxb.	December—March
F. heterophylla Linn.	April—June
F. hispida Linn.	Throughout the year
F. cunia Ham.	Throughout the year
F. glomerata Roxb.	
Artocarpus integra (Thunb.) Merrill	Cultivated
Salicaceae :	
Salix tetrasperma Roxb.	February
Juglandaceae :	
Juglans regia Linn.	July—September, cultivated
Cupulifereae :	
Quercus incana Roxb.	August—October, cultivated

Monocotyledons

Name	Flowering season
Orchidaceae :	
Geodorum densiflorum Suh. ..	April-May
Oberonia falconeri Hook	September-October
Microstylis versicolor Lindl. ..	
Vanda parviflora Lindl.	April-May
V. roxburghii R. Br.	July-August
Habenaria plantaginea Lindl. ..	March-April
H. hollandiana Satnapau ..	April-May
H. grandiflora Lindl.	Monsoon
Zingiberaceae :	
Curcuma longa Linn.	
Zinziber officinale Roxb.	
Cannaceae :	
Canna indica Roxb.	Cultivated
Musaceae :	
Ensete superbum Roxb.	
Bromiliaceae :	
Ananas comosum (Linn.) Merr. ..	Cultivated
Agavaceae :	
Agave wightii Drum.	
A. americana Linn.	
A. vera cruz Mill.	
Dioscoreaceae :	
Dioscorea anguina Roxb. ..	September—January
D. oppositifolia Linn. ..	September-October
D. bulbifera Linn.	August—October

Name	Flowering season
D. hispida Dennst.	July—September
D. pentaphylla Linn.	
D. alata Linn.	Cultivated
Liliaceae :	
Smilax zeylanica Linn.	July—September
Asparagus racemosus Willd. ..	August—November
Gloriosa superba Linn.	July—October
Chlorophytum tuberosum (Roxb.) Baker.	June
Palmae :	
Phoenix acaulis Roxb.	December-January
Phoenix sylvestris (Linn.) Roxb.	
Casurinaceae	Cultivated
Casuarina equisetifolia Forst. ..	September-October, cultivated
Typhaceae :	
Typha angustata Bory and Chaub.	August
Araceae :	
Arisaema murraya (Grahm.) Hook.	June-July
Amorphophallus campanulatus Blume.	
Cyperaceae :	
Cyperus rotundus Linn.	September—November
C. corymbosus Roth.	September—November
Scirpus kysoor Roxb. ..	
Bambuseae :	
Bambusa bambos (Linn.) Voss. ..	After interval of 30 years flowered in 1954 and 1959.
Dendrocalamus strictus Nees. ..	
Apluda mutica Linn.	Cultivated
Chionochne koenigii (Spreng.) Thw.	
Cymbopogon frumantocea Limk.	
Heteropogon contortus (Linn.) Beauv.	
H. ritchei (Hook.) Blatt.	
Panicum miliare Lamk.	
Paspalum scorbiculatum Linn.	
Sehima sulcatum (Rottl.) Stapf.	
Sorghum halepense (Linn.) Pers.	

8. FLORA OF NAGPUR REGION.

An important region of Vidarbha lies on the other side of Wardha River, mainly concentrated around Nagpur, the former Capital of the Central Provinces and Berar. It is a seat of the University and yet no flora of this place or region has been worked out by any Botanist. Only lists of plants of Telankhedi Farms and around Nagpur are available. They contain about 310 plants and are useful. Recently Balapure (1966) has been describing plants of Nagpur and Ramtek area and Mirashi's (1954—1963) lists of plants around Nagpur are available. Earlier Brandis (1874) and Hooker (1856) had casually mentioned some plants of this area.

Recently Balapure (1966) who has been working on Nagpur, Ramtek, Akola, Jabalpur flora states that there are at least 2000 plants in the old Central Provinces area. Graham's list (1911) is only a fragment of it. Tiwari (1954—56) has also reported a number of grasses in this area, and Mirashi (1954—1959) studied the Water Plants in Nagpur and Umred tanks. All these lists are incomplete, but we have to depend upon them for whatever information we have on the flora of Nagpur region. In 1971 Balapure (1971) described some additional plants from Ramtek, about 45 km north-east of Nagpur. He has particularly drawn attention to the species that appear in the lakes, ponds, river banks and marshy places. He has also described the undergrowth on the wet soil of ponds, and weeds commonly found in the post-monsoon season at Ramtek. Here he describes 130 plants of Ramtek. He also has added some new records for the area.

Nagpur is about 548.6 metres high above the Sea level. It lies in the Wardha—Wainganga basin. It is surrounded by small hillocks around. They rise 275.2 metres above. The rainfall is between June and October. It is more than in parts of Western Maharashtra. For example, Pune which has a similar situation gets only 610—685 mm of rain, whereas Nagpur gets 1016—1270 mm of rain. The result is the slopes of hills around Nagpur are well covered by *Tectona grandis, Hardwickia binata, Gardenia lucida, G. resinifera* and do not look dry. Small hills have a few trees of *Anogeissus latifolia, Terminalia paniculata, Flacourtia ramonchi, Diospyros melahoxylon* etc. These species shed their leaves completely in the hot season which is prolonged, and has a temperature of 81.50°F. This is in clear contrast with the vegetation at other places in Western Maharashtra. The species here develop mixed deciduous forest. In the summer months grasses and other herbaceous vegetation gets charred and dries up as in Western Maharashtra, and hillocks look barren as in other parts. The cold months from November to February are pretty cold. The temperature reaches a low marks of 3.40°, at the same time the maximum temperature goes up during day time to about 32°C degrees. The light lasts longer in day and nights are pretty cold, since we have moved northwards. No endemics have been recorded so far in Nagpur flora. The soils in the hilly areas are quite shallow, but fertile. Underground water table is deep. Around Nagpur, and from Wardha and beyond, the soils are derived from Deccan traps and are rich black cotton soils. But in Nagpur region towards Amravati, Bhandara and Chandrapur they are sandy loam derived from sand-stones of the Vindhyan origin. As a matter of fact one can see the Vindhyan sandstone overlain by a thin layer of Lametas and they in turn covered by 30-40' thick flows of Deccan trap. This situation is very clear on the well known Hill fort of Sitabardi opposite to the Nagpur Railway Station or at Satnavari on Nagpur-Amravati road and also in wells at various places 16 km to 19 km off Nagpur. The forest mainly consists of dry deciduous species of *Tectona grandis, Butea monosperma, Acacia fernasiana, Terminalia arjuna, Combretum ovalifolium, Gmelina asiatica, Ficus hispida, Phoenix sylvestris, Bauhinia racemosa, Acacia leucophloea, Acacia catechu, A. pinnata, Carissa congesta Lepidagathis cristata, L. mitis, Lantana camara* etc.

The small trees and shrubs here may be mentioned as.—*Wrightia tinctoria, Capparis zeylanica, C. horrida, Balanites roxburghii, Zizyphus enoplea, Z. xylopyra*, etc. The herbaceous plants are *Berleria cristata, Justicia simplex, Boerhaavia diffusa, Amaranthus tricolor, Aerualanata.*

Grasses *Aristida depressa*, *Eragrostis punioloides*, *Themeda quadrivalas*, *Dicanthium annulatum* are common. This kind of vegetation is pretty common and continues some distance towards Bhandara and Wardha ; but nowhere in this region one notices evergreen or semi-evergreen forest nitches. Obviously the vegetation is of the mixed deciduous type. This is because the rainfall is more and better distributed during *kharif* and *rabi* seasons, and because the soils here are black cotton or the sandy loam highly fertile.

These forests lie very often directly above the trap soils intercalated with intertrappean layers of reddish or greenish soils. Below them are the rich beds of coal. It is being mined at Korhadi near Nagpur, Kamathi, Umred and from mines towards Sausar. Coal is rather of low grade as it contains a large proportion of ash or silica. It is extensively used by the industry around. This coal was first detected on the basis of *Glossopteris* leaf impressions found at Kamathi by the Rev. Dr. Hislop nearly 150 years ago. He had also noticed a rich Intertrappean flora around Nagpur in the intertrappean beds at Takli hill, Bharatwada and other places. The present day flora of Nagpur is successor to the Gondwana flora capped by intertrappean flora found at several places in Nagpur area. The best development of the *Glossopteris* flora in this area is in the Wardha-Godavari Valley. The Intertrappean flora is found around Nagpur, Paradshinga, Sausar, Bor Nala and in the hills near Varoda on Ballharsha road. However the best known intertrappean flora is found in the locality of Mohgaon Kalan, first discovered by Dr. K. P. Rode of Udaipur. We shall consider them in the chapter on fossil flora of Maharashtra.

Bhandara and Gadchiroli districts constitute the eastern boundary of Maharashtra State. Chandrapur and Gadchiroli form a very distinct unit of the flora, though not botanically ; because the district Chandrapur is well forested, has more rainfall and higher humidity for about 6-8 months. It is also not having the trap soils but sandy soils which encourage better growth of roots. That is not however the case with the district Bhandara. It has sandy soils or river alluvium in certain parts, and blackcotton soils in other parts. The soils having Deccan traps below encourage flora similar to that in Nagpur. The loamy soils have several plants in addition to those from Western Maharashtra, those from Orissa and Madhya Pradesh districts. However, the common feature of them is the presence of dry deciduous vegetation consisting of *Tectona grandis* with *Adina cordifolia*, *Terminalia arjuna* or *T. tomentosa* as their associates. These species often grow with *Hardwickia binata* and *Lannea grandis*. The last two species suggest dry nature of environment. The presence of *Adina cordifolia*, abundance of *Mangifera indica* in places like Patur suggest better conditions of rainfall, but the climate is very h-ot and intolerable for about 4 summer months. It kills many nonwoody species. The flora of Chandrapur will be considered separately, as it is the largest district in size and is very well forested.

It may be mentioned here that Graham's (1911) list has not mentioned many plants belonging to Nymphacaceae, Linaceae, Labiateae, Nyctaginaceae, Alismaceae or grasses later discovered by Mirashi or Balapure, Eriocaulaceae and Cyperaceae. About 100 more species belonging to over 35 families have been added to Nagpur flora by Balapure and Mirashi, but the list is awaiting publication.

Wild Plants at Nagpur and Telankhedi Farm

(After Graham 1911, Witt 1908 and others)

Name	Flowering period
Menispermaceae	
Tinaspora cordifolia Miers ..	July-August.
Cocculus villosus DC	September-November.
Cissampelos pereirae Linn ..	September.
Papaveraceae	
Argemone mexricana Linn ..	All the year.
Cruciferae	
Nasturtium indicum DC	
Capparidaceae	December.
Cleome simplicifolia H. F. and T	August-September.
Cleome viscosa Linn	July-September.
Cleome chelidonii Linn	July-August.
Gynandropsis pentaphylla DC ..	August-October.
Capparis horrida Linn. f	April.
Violaceae	
Ionidium suffruticosum Ging ..	July-September.
Polygaleae	
Polygala erioptera DC	July-September.
Polygala chinensis Linn	June-December.
Caryophyllecae	
Saponaria vaccaria Linn	April.
Polycarpaea corymbosa Lamk ..	August.
Portulacae	
Portulaca olerecea Linn	July-December.
Portulaca quadrifida Linn ..	August-May.
Malvaceae	
Sida humilis Willd	
Sida mysorensis W. and A. ..	August-December.
Sida spinosa Linn	July-October.
Sida carpinifolia Linn	August-December.
Sida rhombifolia Linn	July-January.
Sida cordifolia Linn	June-December.
Abutilon indicum G. Don. ..	December.
Abutilon graveolens W. and A. ..	June.
Malachra cipitata Linn	August.
Urena lobata Linn	October-December.
Urena sinuta Linn	August-December.
Hibiscus pandurae-formis Burm.	August-December.
Hibiscus ficulneous Linn	August-October.
Hibiscus rugosus Mast	August-September.
Sterculiaceae	
Helicteres isora Linn	August-September.
Melochia corchorifolia Linn ..	August-September.

Name	Flowering period
Tiliaceae	
Grewia salvifolia Heyune ..	September.
Grewia asiatica Linn	July-March.
Grewia hirsuta Vehl	August.
Triumfetta rhomboidea Jacq ..	July-September.
Triumfetta rotundifolia Lamk ..	August-December.
Corchorus olitorius Linn	July-December.
Corchorus trilocularis Linn ..	June-December.
Corchorus fascicularis Lamk ..	November-December.
Corchorus acutangulus Lamk ..	August-September.
Malpighiaceae	
Aspidopterys cordata Juss ..	December.
Zygophylleae	
Tribulus terrestris Linn	September-December.
Geraniecceae	
Oxalis corniculata Linn	June-April.
Biophytam sensitivum DC ..	July-September.
Impatiens balsamina Linn ..	July-September.
Simarubaceae	
Balanites roxburghii Planch ..	December.
Meliaceae	
Melia azadirach Linn	May.
Rhamnaceae	
Ventilago calyculata Tulasna ..	October-November.
Zizyphus jujuba Lemk	April-September.
Zizyphus oenoplia Mill	August-September.
Zizyplius xylopyrus Willd.. ..	July
Ampelideae	
Vitis repanda W. and var *Linnaei* Wall. ..	July-August.
Vitis linnaei Wall	June-August.
Vitis latifolia Roxb	July-September.
Vitis setosa Wall	July-August.
Vitis carnosa Wall	July-August.
Sapindaceae	
Cardiospermum halicacabum Linn	July-December.
Leguminosae	
Heylandia latebrosa DC	August-December.
Crotalaria hirsuta Willd	September.
Crotalaria pumila Heyne	September.
Crotalaria mysorensis Roth ..	September-December.
Crotalaria linifolia Linn	July-October.
Crotalaria calycina Schrant ..	July-September.
Crotalaria retusa Linn	August-November.
Crotalaria orixensis Rottl ..	August-November.
Melitotus parviflora Desu ..	January-March.
Melilotus alba Lamk	January-March.
Indigofera linifolia Restz	June-December.

Name	Flowering period
Indigofera linifolia var. *campbelii* Wight.	June.
Indigofera cordifolia Heyne	August-November.
Indigofera glandulosa Willd	September-December.
Indigofera anneaphylla Linn	June-December.
Indigofera trifoliata Linn	September-December.
Indigofera trita Linn	September-November.
Indigofera hirsuta Linn	September-January.
Psoralea corylifolia Linn	September-October.
Tephrosia purpurea Pers	July-December.
Tephrosia villosa Pers	August-November.
Sesbania aculeata Pers	September-December.
Zornia diphylla Pers	August.
Smithia geminiflora Roth	November-December.
Aeschynomene Indica Linn	July-September.
Pseudarthria viscida W. and A	September.
Uraria picta Desu	July-September.
Uraria lagopoides DC	August-September.
Alysicarpus monilifer DC	July-December.
Alysicarpus vaginalis DC	October.
Alysicarpus bupleurifolius	
Alysicarpus rugosus DC var. *heyneanus* Baker.	October-November.
Alysicarpus rugosus DC var. *styracifolia* Baker.	October-December.
Alysicarpus tetragonolobus Edgw	July-December.
Desmodium taxiflorum DC	October.
Desmodium gangeticum DC	August-December.
Desmodium diffusum DC	October.
Desmodium triflorum DC	June-December.
Abrus precatorius Linn	August.
Teramnus labialis Spreng	August-September.
Mucuna pruriens DC	October-December.
Erythrina indica Lamk.	
Butea frondosa Roxb	March.
Canavalia ensiformis DC	
Phaseolus trilobus Ait	August-October.
Phaseolus aconitifolius Jacq	August-December.
Phaseolus trinervius Heyne	August-November.
Clitoria ternatea Linn	August.
Clitoria ternatea var. *pilosalaz* Baker.	
Atylosia scarobaeoides Benth	September-December.
Atylosia platycarpa Benth	September.
Rhynchosia minima DC	June-December.
Caesalpinia bonducella Flemming	September-October.
Parkinsonia aculeata Linn	March-April.
Cassia occidentalis Linn	July-January.
Cassia tora Linn	August-October.
Cassia obtusifolia Linn	August-October.
Cassia absus Linn	July-September.
Cassia pumila Lamk	August-November.
Cassia mimosoides Linn	August-November.
Neptunia triquetra Benth	July-August.
Dichrostachya cinerea W. and A	August-January.

Name	Flowering period
Leucaena glauca Benth	August-April.
Mimosa hamata Willd	June-September.
Acacia farnesiana Willd ..	December-January.
Acacia arabica Willd	August-December.
Acacia leucophlaed Willd ..	August-September.
Acacia catechu Willd	August-September.
Acacia pennata Willd	June.
Pithecolobuim dulce Benth ..	April.
Combretaceae	
Terminalia arjuna Bedd	May.
Combretum ovalifolium Roxb ...	February-March.
Quisqualis indica Linn	
Lythraceae	March—June.
Ammannia pentandra Roxb ..	December.
Ammannia baccifera Linn ...	December.
Ammania salicifolia Manth. ..	October-December.
Woodfordia floribunda Salisb ..	January-March.
Lawsonia alba Lamk	June.
Onagraceae	
Ludwigia parviflora Roxb.. ...	July-August.
Passifloreae	
Passiflora foetida Linn	July-August.
Trichosanthes cucumerina Linn ..	July-September.
Cactaceae	
Momordia dioeca Roxb.	July-September.
Momordica cymbalaria Eng. ..	August.
Cephalandra indica Naud ..	
Cucumis trigonus Roxb	July-January.
Bryonia laciniosa Linn	September-October.
Mukia scabrella Arn.	July-October.
Zehneria umbellata Thw ...	August-September.
Oocteae	
Opuntia dillenii How	July-October.
Ficoideae	
Trianthema monogyna Linn ...	January.
Mollugo hirta Thunb	December-April.
Mollugo stricta Linn	July-December.
Rubiaceae	
Oldenlandia corymbosa Linn ...	August-December.
Anotis montholini Hook	August.
Knoxia corymbosa Willd ...	July-October.
Spermacoce stricta Linn	August-September.
Spermacoce hispida Linn.. ...	July-November.
Compositae	
Vernonia cinerea Less	January-March.
Ageratum conyzoides Linn ...	June-August.
Cythocline gyrata Cass	October-January.

Name	Flowering period
Grangea maderaspatana Poir	January-April.
Sphaeranthus indicus Linn	December-April.
Gnaphalium luteo-album Linn	December-April.
Caesulia axillaris Roxb.	October-December.
Vicoa auriculata Cass	July-December.
Pulicaria angustifolia DC.	August-January.
Lagascea mollis Cav	July-October.
Xanthium strumarium Linn	November-December.
Euipta alba Hassk.	July-December.
Blainvillea latifolia DC	August-December.
Spilanthes acemella Linn	July-December.
Glossocardia linearifolia Cass	July-November.
Bidens pilosa Linn	July-August.
Glossogyne pinnatifida DC	July-September.
Tridex procumbens Linn	July-October.
Flaveria contrayers Pers	June-January.
Echinops echinatus DC	October-May.
Coniocaulon glabrum Cass	July-July.
Voluturella divaricata Benth	August-November.
Sonchus arvensis Linn	September-January.
Launaea nudicaulis Cass	April.
Plumbagineae	
Plumbago zeylanica Linn	July-December.
Apocynaceae	
Carissa carandas Linn	March.
Vinca pusilla Merr	August-September.
Asclepiadeae	
Hemidesmus indicus Br.	August.
Cryptolepis buchanani Roem	May-July.
Oxystelma esculentum Br.	August.
Cryptostegia grandifolia Br.	July-November.
Calotropis gigantea Br.	June-February.
Daemid extensa Br.	August-December.
Holostemma rheedei Wall	August.
Dregea volubilis Benth	August.
Leptadenia reticulata W. and A.	July.
Gentianaceae	
Exacum pedunculatum Linn	October-December.
Hoppea dichotoma Willd	November-December.
Enicostema littorale Blume	June.
Erythraea roxburghii D. Don	February-April.
Canscora decurrens Dalz	October-February.
Boraginaceae	
Heliotropium ovalifolium Forsk	May-July.
Heliotropium paniculatum Br.	August-September.
Trichodesma indicum Br.	August-September.
Trichodesma indicum Br.	June-December.
Trichodesma amplexicule Both	June-December.
Convolvulaceae	
Rivea hypocrateriformis Chois	August-September.
Argyreia sericea Dalz.	August-September.

Name	Flowering period
Ipomoea coccinea Linn	October-November.
Ipomoea quamoclit Linn	September.
Ipomoea pes-tigridis Linn ..	September-October.
Ipomoea eriocarpa Br.	September-December.
Ipomoea reniformis Chois ..	October-April.
Ipomoea obscura Ker	July-September.
Convolvulus arvensis Linn.. ..	August-January.
Convolvulus parviflorus Vahl ..	September-November.
Evolvulus alsinoides Linn ..	July-April.
Solanaceae	
Solanum nigrum Linn	August-December.
Solanum xanthocarpum Schrad and Wendl.	Throughout the year.
Physalis minima Linn	June-October.
Withania somnifera Dunal ..	September.
Datura fastuosa Linn	September.
Datura fastuosa var *alba* Clarke	October.
Scrophularineae	
Celsia coromandeliana Vahl. ..	October-April.
Stemodia viscosa Roxb.	July-December.
Herpestis monnicra H. B. K. ..	July.
Vandellia crystacea Benth ..	August.
Bonnaya brachiata Link	August.
Striga densiflora Benth	July-September.
Striga lutea Lour	
Striga euphratioides Benth ..	July-September.
Sopubia delphinifolia G. Don ..	August-November.
Pedalineae	
Martynia diandra Glox	August-September.
Hygrophila spinosa T. And. ..	November.
Calophanes nagchana Nees ..	April.
Ruellia prostrata Lamk	July-January.
Ruellia patula Jacq.	June.
Blepharis boerhaviaefolia Pers ..	July-December.
Barleria prionitis Linn	October.
Barleria cristata Linn	September.
Andrographis echiodes Nees ..	August-December.
Lepidagathis cristata Willd ..	September-November.
L. mitis Dalz.	October.
Justicia quinquangularis Koen ..	June-October.
Justicia diffusa Willd	June-December.
Rungia elegans Dalz.	October-December.
Peristrophe bicalyculata Nees ..	October-December.
Verbenaceae	
Lantana camara Linn	August-October.
Lippia nodiflora Rich	May-December.
Stachytarpheta indica Vahl. ..	July-September.
Gmelina asiatica Linn	April-August.
Clerodendron serratum Spreng ..	August.
Labiatae	
Ocimum canum Sims	July-December.
Ocimum basillicum Linn. ..	July-April.

Name	Flowering period
Orthosiphon pallidus Royle	August-September.
Plectranthus incanus Link.	September-December.
Anisomeles ovata Br.	October-December.
Laucas cephalotes Spreng	July-September.
Laucas urticaefolia Br.	August-December.
Laucas aspera Spreng	August-December.
Leonotis nepetaefolla Br.	November-December.
Nyctagineae	
Mirabilis jalapa Linn.	..
Boerhaavia repens Linn.	Throughout the year.
Amaranthaceae	
Celosia argentea Linn.	September-November.
Digera arvensis Forsk	August-December.
Amaranthus spinosus Linn.	July-April.
Amaranthus blitum Linn.	July-January.
Pupalia lappacea Moq.	September-December.
Aerua lanata Juss	July-December.
Achyranthes aspera Linn.	July-October.
Alternanthera sessilis Br.	...
Chenopodiaceae	
Chenopodium album Linn.	January.
Basella rubra Linn.	October-December.
Polygonaceae	
Polygonum plebejum Br.	July-April.
Aristolochiaceae	
Aristolochia bracteata Retz	September.
Laurineae	
Cassytha filiformis Linn.	August-September.
Euphorbiaceae	
Euphorbia cristata Heyne	September.
Euphorbia hypericifolia Linn.	August-January.
Euphorbia pilulifera Linn.	Throughout the year.
Euphorbia rosea Retz	June-August.
Euphorbia thymifolia Burm.	Throughout the year.
Euphorbia dracunculoides Lamk.	December-January.
Euphorbia rothiana Spreng	December.
E. geniculata Orteg.	July-October.
Phyllanthus reticulatus Poir.	July-December.
P. maderaspatensis Linn.	July-January.
P. simplex Retz	July-November.
P. niruri Linn.	July-August.
Fleuggia microcarpa Blume	July-August.
F. leucopyrus Willd.	May-August.
Jatropha gossypifolia Linn.	May-August.
Jatropha curcas Linn.	May-August.
Chrozophora plicata A. Jass.	October.
C. prostrata Dalz.	May-July.
Acalypha malabarica Muell.	June-October.
Acalypha ciliata Forsk	July-August.
Baliospermum axillare Blume	May-October.
Tragia involucrata Linn.	July-December.

Name		Flowering period
Urticaceae		
Ficus religiosa Linn.	..	September.
F. hispida Linn. ..	..	August.
F. glomerata Roxb. ..	..	August.
Fleurya interrupta Gaud.	..	August.
Orchideae		
Habenaria marginata Coleb.	..	August-September.
Amaryllideae		
Curcuago orchioides Gaertn.	..	July.
Dioscoreaceae		
Dioscorea bulbifera Linn.	..	July-September.
Liliaceae		
Asparagus racemosus Willd.	..	October-December.
Gloriosa superba Linn. ..	..	August-September.
Commelinaceae		
Commelina bengalensis Linn.	..	August-September.
Aneilema nudiflorum Br.	..	August-September.
Cyanotis cristata Schult. f.	..	August-September.
C. axillaris Roem and Sch.	..	July-August.
Palmeae		
Phoenix sylvestris Roxb. ..	..	March-April.
Typhaceae		
Typha angustata Chaub and Bory		April.

PLANTS OF RAMTEK [After Balapure (1971)]

Name			Locality
Nymphaeaceae :			
Nymphaea nauchali Burm f. (*N. pubescens* Willd.)			
Capparidaceae :			
Capparis zeylanica Linn.			
Malvaceae :			
Hibiscus cannabinus Linn.			
H. lobatus (Murr.) O. Kze	..	..	Nagarjun hill.
Sida spinonsa Linn.			
Pavonia zeylanica Cav.	..	..	Ramtek Forest Division.
Tiliaceae :			
Corchorus fascicularis Lam.			
Linaceae :			
Linum usitatissimum Linn.			
Malpighiaceae :			
Aspidopterys wallichii Hook. f.			
Anacardiaceae :			
Mangifera indica Linn.			

Name	Locality
Papilionaceae :	
Crotolaria albida Heyne ex Roth	Ramtek Forest Division.
Indigofera linifolia Retz.	
I. trita Linn. f.	
I. glandulosa Willd.	
Alysicarpus rugosum DC var.*styracifolius* Baker.	
A. hamosus Edgew	Nagarjun hill.
Dolichos lablab Linn.	
Smithia sensitiva Ait.	Do.
Phaseolus trilobus Ait.	
Desmodium diffusum DC.	
Cicer arietinum Linn.	
Rhynchosia bracteata Benth	Do.
Sesbania bispinosa (Jacg) W. F. Wight.	
S. aculeata Pers.	
Lathyrus sativus Linn.	
Clitoria ternatea Linn.	
Caesalpiniaceae :	
Bauhinia racemosa Lamk.	
Acacia farnesiana Willd.	
A. niliotica (L.) Del.	
—(*A. arabica* Willd.)	
A. leucophleoa Willd	
Trapaceae :	
Trapa natans Linn. var *bispinosa* (Roxb) Makino	
Onagraceae :	
Jussiaea linifolia Wall.	Ramtek Forest Division.
J. repens Linn.	
Cucurbitcaceae :	
Cucumis trigonus Roxb.	
Melothriamaderaspatana (L) Cong.	Nagarjun hill.
Rubiaceae :	
Oldelandia corymbosa Linn.	
Compositae :	
Ageratum conyzoides Linn.	
Grangea maderaspatana Poir.	
Goniocaulon glabrumeass	
Vernonia cinerea Less.	
Volutarella racemosa (Roxb) Santapau.	
(*V. divaricata* Benth. and Hook.)	
Plumbaginaceae :	
Plumbago zeylanica Linn.	On way to Surriver.

Name	Locality
Ebenaceae :	
Diospyros melanoxylon Roxb. ..	Common in forest.
Apocynaceae :	
Ichnocarpus frutescens Br.	
Wrightia tinctoria R. Br.	
Loganiaceae :	
Strychnos potatorum Linn.	
Gentianaceae :	
Nymphoides cristatum (Roxb) O. Kuntze. (= *Limnanthemum indicum* Griseb.).	
Exacum pedunculatum Linn.	
Enicostemma littorale Blume	
Boraginaceae :	
Heliotropium ovalifolium Forsk	
Trichodesma zeylanicum R. Br.	
Convolvulaceae :	
Ipomoea aguatica Forsk	
I. hispida (Valil.) R. and S.	
Scrophulariaceae :	
Lindernia ciliata (Colsm.) Pennell. ..	Nagarjun hill.
(= *Bonaya brachiata* Link and Otto).	
Yeronica anaagallis Linn.	
Striga euphrasioides Benth.	Nagarjun hill.
Stemodia viscosa Roxb	
Lantibulariocea :	
Utricularia flexuos Vahl.	
Acanthaceae :	
Hygrophila polysperma T. Anders.	
Daedalacanthus purpurascens T. Anders. ..	Nagarjun hill.
Barleria cristata Linn.	Nagarjun hill.
Rungia parviflora Nees	Forest near Khindsi tank.
Labiatae :	
Hyptis suaveolens Poir.	Ramtek forest.
Nyctaginaceae :	
Boerhcevia diffusa Linn. ..	Nagarjun hill.
Amaranthaceae :	
Amaranthus tricolor Linn.	
Aerua lanata Juss.	Nagarjun hill.
Nothosaerva brachiata L.	Ramtek forest
Digera muricata (Linn.) Mart.	

Name	Locality
Polygonaceae :	
Polygonum hydropiper Linn.	Nagarjun hill.
Euphorbiaceae :	
Euphorbia hirta Linn.	Ramtek Forest.
E. perbracteata Gage	
Phyllanthusmaderaspatensis Linn.	
Iragia cannabira Linn. f. ..	
Urticaceae :	
Ficus tomentosa Roxb.	
Commelinaceae :	
Commelina hasskarllii B. Cl.	Sur river.
Cyanotisaxillaris (Linn.) Schuttz. f. ..	Nagarjun hill.
Alismaceae :	
Sagittaria sagittifolia Linn.	
Butomopsis lanceolata Kunth	
Eriocaulaceae :	
Eriocaulon quinquangulare Linn. ..	Nagarjun hill.
Cyperaceae :	
Bulbostylis barbata Kunth	Nagarjun hill.
Eleocharis atropurpurea Kunth	
Cyperus sanguinolentus Vahl.	Sur river.
C. pumilus Nees..	Nagarjun hill.
C. iria Linn.	Sur river.
C. fiffusus Roxb.	Sur river.
C. eleusinoides Kunth	Nagarjun hill.
C. flavidus Actz.	Sur river.
Scirpus supinus Linn.	
S. kernii Raymond	Amba tank.
Fimbristylis schoenoides Vahl. ..	Nagarjun hill.
F. tetragona R. Br.	Nagarjun hill.
Fimbristylis monostachya Hassk.	Sur river.
F. diphylla Vahl.	Nagarjun hill.
Rhynchospora longisetis R. Br. ..	Nagarjun hill.
Gramineae :	
Aristida depressa Retz	Ramtek forest.
Brachiaria eruciformis Griseb ..	
Elytrophorus spicatus (Willd.) ..	Near ponds.
Eragrostis unioliodes Nees	Nagarjun hill.
E. diarrhena Steud	
E. gangetica Steud	
E. tenella R. and S.	
Ischaemum rugosum Salisb.	
I. molle Hook. f.	
I. seilema laxum Hack.	
Oryzasativa Linn.	

Name	Locality
Sorghum bicolor Moench.	Ramtek.
Themeda quadrivalvis O. Kunz.	
Rottboellia Sp.	
Dichanthium caricosum A. Camus	
D. annualatum Stap. f.	
Vetiveria zizahinoides (Linn.) Nash.	

9. Flora of Chandrapur [1] :

The district Chandrapur is situated between 78°-48′ to 80°-55′ East longitude and 18°-41′ to 20°-50′ North latitude. The greater part of it consists of undulating hill ranges 150 m—450 m above M. S. L. The surrounding plain is cut across by several Nallas and small streams. The river Vainganga passes through the middle of the district touching Vadasa, Armori and Aheri and is joined by river Dina. Together they form Pranahita river which joins Godavari river at Sironcha in Maharashtra. District Bastar of Madhya Pradesh lies to its East and the District Adilabad of Andhra Pradesh lies on its south. The climate is very hot in summer but has well distributed rainfall throughout the District. July is the heaviest rainfall month. Cold season is from Dmecember to February followed by hot season up to June. The monsoon lasts from June to September. October, November form post-monsoon period. Weather storms from the Bay of Bengal cross the district and keep the area humid up to February. The soils are sandy loam derived from granitaees and quartz alluviam of rivers like Pranahita Vainganga. The tops of hills are denuded and have shallow soils. On the lower slopes of hills it is deep and extremely good for the growth of forest trees on the ridges, and in valleys. The flora of this place is not much known. Some plants in this district have been mentioned by Haines (1916) Tiwari (1954-55),—(1963), Tiwari and Maheshwari (1964). However Malhotra and Moorthy (1971), (1973) have given a a fuller account of the flora of the district with localities. Their list contains 780 species spread over 463 genera and 110 families spread over various localities.

The perusal of this list shows that the following are the predominant families.—

	Family	Genera	Species
1.	Fabaceae (Papilionaceae)	82	72
2.	Poaceae (Gramineae)	30	71
3.	Cyperaceae	11	37
4.	Asteraceae (Compositeae)	27	35
5.	Acanthaceae	20	28
6.	Malvaceae	9	25
7.	Rubiaceae	16	25
8.	Convolvulaceae	8	25
9	Caesalpinaceae	9	19
10.	Amarantaceae	11	17
11.	Mimoseae	8	15

[1]. This account pertains to Chandrapur and Gadchiroli Districts.

It is quite obvious from this, that a large number of herbaceous members are found side by side with tree species like *Tectona grandis, Mitragyna parvifolia, Albizzia lebbeck, Anogeissus latifolia, Bombax ceiba, Adina cordifolia, Bridelia retusa, Chloroxylon swietenia, Dalbergia lanceolaria, Stereospermum suaveolens, Soymida febrifuga.* Compared to herbaceous plants, the woody species are few. These woody species form tall canopy. The tree growth of *Tectona* and other tree species here is so good that they hardly indicate the deciduous nature of the forest here. The second layer of plants in the forest is formed by *Adina cordifolia, Butea monosperma, Capparis grandis; Clerodendron serratum, Cleistanthus collinus, Eriolaena hookeri, Erithroxylon monogynum, Gardenia gummifera, G. resinifera, Garuga pinnata, Helicteris isora, Holarrhena antidysenterica, Leea edgeworthii, Pavetta indica, Woodfordia fruticosa, Latana camara* is widely spread in open and waste lands. A number of lianas and climbers of *Abrus precatorius, Ampelocissus latifolia, Aristolochia indica,* grow abundantly with *Atylosia scabraesoides, Dioscorea pentaphylla, Hemidesmus indicus, Ichnocarpus frutescens, Mucuna prurita, Ventilago denticulata* etc.

Due to heavy rainfall and humidity the trees are loaded with epiphytic *orchids* like *Vanda tessellata* and parasites like *Cassytha filiformis, Dendrophthoe falcata, Viscum articulatum* etc. Bamboos and pricky thickets of *Calamus* are plentiful.

The undergrowth consists of *Abutilon indicum, Acalypha indica, Achyranthus aspera, Ageratum conyzoides, Andrographis paniculata, Blumea membranacea, Desmodium gangeticum, Cyanotis cristata, Cyperus species* like *C. rotundus, Dactylectinium aegypticum, Orthosiphon pallidus, Osbeckia zeylanicum, Rhynchosia sures, Yernonia cinerea, Xanthium sturmarium, Zornia gibbosa* etc.

On the countryside in open trees and shrubs of *Ailanthus excelsa, Bauhinia variegata, Azadirachta indica, Calotropis gigantea, Capparis zeylanica, Cassia auriculata, Casuarina equisitifolia, Delonix regia, Derris indica, Hibiscus lampas, Emblica oficinalis, Ficus engbenghalensis F. religiosa, Mangifera indica* are cultivated.

The district has a large number of ponds, small and large, and the intersecting nallas, and rivers. Aquatic plants *Ceratophyllum demersum Nelumbium nucifera, Nymphaea nouchali, N. stellata Pistia stratiotes, Aeschanomene aspera, Dentella repens* are quite common. Besides these one finds herbaceous plants of *Eriocaulon dianae, E. truncatum, Paspalum vaginatum, Rotala indica, Zyris pauciflora* in marshy areas.

It will be seen from this that the flora here is like the flora in the valleys of western Maharashtra. But the growth of trees is much better here than there due to humidity for the most part of the year and good soil.

The timber trees like *Tectona grandis, Stephegyne parvifolia, Adina coridifolia* here grow very best in the whole of India. Analysis of both herbaceous and woody species however indicates the dry deciduous nature of the flora and vegetation. Besides species from Orissa and Andhra Pradesh also grow therein. In Bastar *Tectona grandis* and *Shorea robusta* are found together, but not here. The famous ' Alapalli ' forest is a few km. from Chandrapur and has the tallest and largest timber trees of *Tectona grandis.* It reaches here nearly 120′ height, more than double that at other places.

The Alapalli teak is much valued for its size and figured wood good for veneering. Ordinary teak fetches very high price for furniture and building timber.

The Chandrapur district is populated by Raj Gonds and the Media Gonds. They are a fascinating Girijan community, but extremely poor. Co-operative Societies are formed for them for selling myrobalans (*Terminalia chebula*) and Tendu or bidi leaves (*Diospyros melanoxylon*) and such other minor forest products. Cultivation of medicinal plants is being encouraged for their benefit *e. g.* pink *Vinca*, *V. rosea*. Its roots and leaves contain anticancerous substance, Vinblastin. There is shifting cultivation in the forest here called *Kumri* cultivation. It plays havoc with young plants and saplings and their buds.

It will be seen that the flora of Chandrapur is very rich in having an assemblage of dry deciduous and semi-evergreen or moist deciduous species; but that alone is not its special feature. The special feature is the luxuriant growth of teak (*Tectona grandis*) and other species.

FOREST RESERVE OF ALAPALLI :

A patch of forest rightly called "*Glory of Alapalli*" is kept reserved as a show piece, a permanent preservation plot since, 1963. Shooting is not allowed here. It is situated 14 km. away from Alapalli on Pranahita river. The average rainfall here is 1525—1780 mm. mostly from July to October. Summer temperature is very high 118°. The climate is extremely humid as a number of nallas cross it, soil being mostly alluvial or sandy. The trees develop admirably good root system in loose sandy soil. The growth of teak and other species here is the best in India as good as that of teak in Burma or Malabar.

The trees are the same as we have seen in Melghat and in the other ghat section of Maharashtra on the Desh side, but they are undisturbed. Such virgin forest must have been quite common in the past all over the peninsular India. Even in the valley of Narmada today, it is not so rich or semi-evergreen as this, but perhaps it was so in the past.

SELECTED LIST OF PLANTS FROM THE FLORA OF CHANDRAPUR DISTRICT
[After Malhotra and Moorthy (1971)]

Name	Locality
Dilleniaceae	
Dillenia aurea Smith	Koppela, 108036 A.
Menispermaceae	
Cissampelos pariera Linn. ..	Kistapur, 117181 ;
Nymphaeaceae	
Nymphaea nouchali Burm. ..	Dechali,
N. stellata Willd.	Dechali.
Nelumbonaceae	
Nelumbo nucifera Gaertn. ..	Mesa.
Brassicaceae	
Rorippa indica (Linn.) Hiern ...	Ashti.
Cleomaceae	
Cleome monophylla Linn. ..	Kukdel.

Name	Locality
Capparidaceae	
Capparis grandis Linn. f.	Mesa.
C. sepiaria Linn.	Mesa.
Violaceae	
Hybanthus enneaspermus (Linn.) F. Muell.	Rajura.
Flacourtiaceae	
Flacourtia indica Merr. (Burm. f.)	Vadasa.
Polygalaceae	
Polygala chinensis Linn.	Lakkadkot.
P. elongata Klein	Tadoba.
P. erioptera DC.	Tamurda.
Salomonia oblongifolia DC.	Brahmapuri.
Tamaricaceae	
Tamarix ericoides Rottl.	Chaudampalli nala.
Elatinaceae	
Bergia ammannoides Roxb. ex Roth.	Chandrapur.
Malvaceae	
Abelmoschus esculentus (Linn.) Moench.	Chandrapur (cultivated).
Hibiscus lampas Cav.	Elgurtola.
Hibiscus labatus (J. A. Murray) O· Kize.	Dechali.
Hibiscus panduraeformis Burm.	Markanda.
Kydia calycina Roxb.	Jimalagatta.
Malachra capitata (Linn·) Linn.	Lohara.
Sida mysorensis Wt. and Arn.	Tamurda.
Urena lobata Linn.	Ghantachowki.
Bombacaceae	
Bombax ceiba Linn.	Lakkadkot.
Sterculiaceae:	
Byttneria herbacea Roxb.	Bamni (Sironcha).
Eriolaena hookeriana Wt. and Arn.	Alapalli.
Sterculia urens Roxb.	Tadoba,
Tiliaceae	
Grewia abutilifolia Vent. ex Juss.	Markanda.
G. hirsuta Vahl	Ghantachowki.
G. rothii DC.	Koppela.
G. serrulata DC.	Wamanpalli.
G. tiliaefolia Vahl	Brahmapuri.
Malpighiaceae	
Aspidopteris cordata	Brahmapuri.
Oxalidaceae	
Biophytum reinwardtii Edgew. ex Hook f.	Jamni (Tadoba).

Name	Locality
Balsaminaceae	
Impatiens balsamina Linn.	Nagbhir.
Rutaceae	
Aegle marmelos Corr.	Kanhargaon.
Citrus aurantifolia (Chirst.) Swingle.	Kukdel.
Simarubaceae	
Ailanthus excelsa Roxb.	Kanhargaon
Balanites aegyptiaca (Linn.) Delile.	Kanhargaon.
Burseraceae	
Boswellia serrata Roxb.	Manekshahgadh.
Garuga pinnata Roxb.	Rajura.
Meliaceae	
Soymida febrifuga A. Juss.	Sondo (Rajura).
Olacaeceae	
Olax scandens Roxb.	Rajura.
Cassine glauca (Rottb.) O. Kuntz.	Ghodejhari (Nagbhir)
Celastrus paniculata Willd.	Elgurtola.
Meytenus emarginata (Willd.) Ding How.	Lakkadkot.
Rhamnaceae	
Ventilago denticulata Willd.	Dechali.
Zizyphus mauitiana Lamk.	Repanpalli.
Z. oenoplia Mill.	Ghantachowki.
Z. rugosa Lamk.	Kotagul.
Z. xylopyra Willd.	Rajura.
Vitaceae	
Cayratia trifolia (Linn.) Domin	Mesa.
Vitis linnaei Wall.	Chandrapur.
Leeaceae	
Leea edgeworthii Sant.	Pimpalkhuta (Koisa).
L. herbacea Ham.	Junona.
L. macrophylla (Roxb.) Hornem	Somanpalli.
Sapindaceae	
Schleichera oleosa (Lour.) Oken	Keslaghat.
Anacardiaceae	
Buchanania lanzan Spreng.	Rajura.
Lannea coromandelica (Houtt.) Merr.	Brahmapuri.
Semecarpus anacardium Linn. f.	Manekshahgadh.
Moringaceae	
Moringa concanensis Nimmo	Lakkadkot.
M. oleifera Lamk.	Murumgaon.

Name		Locality
Fabaceae		
Aeschynomene aspera Linn.	..	Naleshwar.
A. indica Linn.	..	Ghantachowki.
Alysicarpus monilifer (Linn.) DC.		Lakkadkot.
Atylosia platycarpa Linn.	..	Khatoda (Tadoba).
A. scarabaeoides (Linn.) Benth.		Ghantachowki.
Butea monosperma (Lamk). Taub.		Manekshahgadh.
Canavalia ensiformis DC.	..	Bamni (Sironcha).
Clitoria orixensis Willd. ..	..	Chandur.
Dalbergia lanceolaria Linn. f.	..	Pangri (Kolsa).
D. latifolia Roxb. ..	..	Manekshahgadh.
D. sissoo Roxb.	..	Ballarpur.
Derris indica (Lamk).) Bennet	..	Kotagul (Bergaon).
D. scandens (Roxb.) Benth.	..	Wamanpalli.
Desmodium gangeticum (Linn.)DC		Dechali.
D. heterocarpon (Linn.) DC	..	Elchill
Eleiotis monophylla (Burm. f.) DC		Elgurtola.
Indigofera tinctoria Linn.	..	Alapalli.
Moghania strobilifera St. Hil ex Jacks.		Kurkheda.
Mucuna prurita Hook. ..	..	Lakkadkot.
Pseudarthria viscida Wt. and Arn.		Somanpalli.
Psoralea corylifolia Linn.	..	Markanda.
Pterocarpus marsupium Roxb.	..	Wirur.
Rhynchosia aurea DC ..	..	Khatoda (Tadoba).
Sesbania bispinosa (Jacq.) Fawcett et Rondle.	..	Ghantachowki.
Smithia confera Sm. ..	..	Nagbhir.
Tephrosia hirta Buch. Ham.	..	Wamanpalli.
T. purpurea Pers.	..	Ghantachowki.
T. strigosa (Dalz.) Sant. and Mahesh.		Katejhari (Tadoba).
Vigna radiata (Linn.) Wilczok	..	Chandrapur.
V. triloba (Linn.) Verde.	..	Warora.
Caesalpiniaceae		
Bauhinia purpurea Linn.	..	Rajura.
B. racemosa Lamk. ..	..	Lakkadkot.
B. variegata Linn. ..	..	Dechali.
Caesalpinia pulcherrima (Linn.) Sw.		Sironcha.
Cassia absus Linn. ..	...	Rajura.
C. fistula Linn.	..	Kanhargaon.
C. pumila Lamk. ..	..	Tamurda.
Piliostigma malabaricum Benth.		Choaudmpalli.
Mimosaceae		
Acacia chundra (Roxb.) Willd.	..	Asaralli.
A. leucophloea Willd. ..	..	Lakkadkot.
A. nilotica (Linn.) Del. subsp. *indica* (Benth.) Brenan.		Ashti.
Albizzia lebbek (Linn.) Benth.	..	Lakkadkot.
Mimosa hamata Willd.	..	Lakkadkot.
M. rubicaulis Lamk. ..	..	Somanpalli.
Samanea saman (Jack.) Merr.	..	Chandrapur (planted).
Xylia xylocarpa Taub.	..	Garlapeth (Wirur).

Name	Locality
Saxifragaceae	
Vahlia digyna (Roxb.) O. Kuntze. ..	Ashti.
Droseraceae	
Drosera burmanni Vahl ..	Keslaghat.
Haloragaceae	
Myriophyllum spathulatum Blatt. and Hallb. ..	Tadoba.
Combretaceae	
Anogeissus latifolia (Roxb.) ex DC. Bedd. ..	Manekshahgadh.
Calycopteris floribunda (Roxb.) Lamk. ..	Maseli (Bergaon).
Combretum decandrum Roxb. ..	Kurkheda.
C. ovalifolium Roxb.	Keslaghat.
Terminalia arjuna (Roxb. ex DC) Wt. and Arn.	Garlapeth (Wirur).
T. bellerica (Gaertn.) Roxb. ..	Tamurda.
T. chebula Retz.	Rajura.
T. crenulata Roth	Pandarpani (Tadoba).
T. tomentosa Wt. and Arn. ..	Lakkadkot.
Myrtaceae	
Syzygium cumini (Linn.) Skeels ..	Dechali.
S. heyneanum Wall.	Keslaghat.
Barringtoniaceae	
Barringtonia acutangula (Linn.) Gaertn. ..	Aheri.
Lecythidaceae	
Careya arborea Roxb. ..	Katejhari (Tadoba).
Melastomaceae	
Melastoma malabathricum Linn.	Bamni (Sironcha)
Memecylon umbellatum Burm. ..	Dechali.
Lythraceae	
Lagerstroemia parviflora Roxb.	Sironcha.
Rotala indica (Willd.) Kochne ..	Dechali.
Woodfordia fruticosa (Linn.) Kurz.	Lakkadkot.
Oangraceae	
Ludwigia hyssopifolia (G.Don) Exell. ..	Somanpalli.
L. octovalis (Jacq.) Raven subsp. *sessilifora*.	Bamni (Sironcha).
L. perennis Linn.	Tamurda.
Samydaceae	
Casearia elliptica Willd. ..	Keslaghat.
C. graveolens Dalz.	Armori.
Caricaceae	
Carica melo Linn. var. *agrestis* Naud. ..	Nagbhir.
Mukia maderaspatana (Linn.) Roem. ..	Ghantachowki.

Name	Locality
Molluginaceae	
Glinus lotoides Linn.	Ashti.
G. oppositifolius (Linn.) A. DC.	Junona.
Mollugo nudicaulis Lamk. ..	Rajura.
Alangiaceae	
Alangium salvifolium (Linn. f.) Wang. ..	Armori.
Rubiaceae	
Adina cordifolia (Roxb.) Hook. f. ex Brandis.	Somanpalli.
Borreria articularis (Linn. f.) F. N. Will. ..	Ghantachowki.
B. pusilla (Wall.) DC.	Mesa.
Canthium parviflorum Lamk. ..	Mesa.
Dentella repens (Linn.) J. R. and G. Forst.	Kukdel (Bergaon).
Gardenia gummifera Linn. ..	Kanhargaon.
G. latifolia Ait.	Lakkadkot.
G. resinifera Roth	Rajura.
G. turgida Roxb.	Rajura.
Hydyotis caerulea Wt and Arn.:	Pambhurna.
H. nudicaulis Wt. and Arn. ..	Bamni (Sironcha).
H. umbellata Lamk.	Bamni (Sironcha).
Ixora arborea Roxb. ex Sm. ..	Dechali.
Knoxia sumatrensis (Retz.) Korth.	Dechali.
Mitragyna parvifolia (Roxb.) Korth. ..	Ghantachowki.
Pavetta indica Linn.	Markanda.
Xeromphis spinosa (Thunb). Keay	Rajura.
X. uliginosa (Retz.) Mahesh. ..	Brahmapuri.
Asteraceae	
Acanthospermum hispidum DC. ..	Ghantachowki.
B. obliqua (Linn.) Druce ..	Kanhargaon.
Echinops echinatus Roxb. ..	Chandur.
Elephantopus scaber Linn. ..	Bamni (Sironcha).
Grangea maderaspatana (Linn.) Poir. ..	Kukdel.
Parthenium hysterophorus Linn. ..	Chandrapur.
Vernonia anthelmintica Willd. ..	Junona (Chandrapur).
Xanthium strumarium Linn. ..	Ghantachowki.
Lobeliaceae:	
Lobelia alsinoides Lamk. ..	Khatoda side (Tadoba).
Campanulaceae	
Wahlenbergia marginata (Thunb.) A. DC.	Kurkheda.
Plumbaginaceae	
Plumbago zeylanica Linn. ..	Manekshahgadh.
Primulaceae	
Anagallis arvensis Linn. ..	Karva (Ballarpur).
Myrsinaceae	
Embelia tsjarium-cottam A. DC.	Brahmapuri.

Name	Locality
Sapotaceae	
Madhuca longifolia (Koenig) Macb. var. *latifolia* (Roxb.) Chev.	Garlapeth (Wirur).
Manikara achras (Mill.) Fosberg.	Wirur (Planted).
Oleaceae	
Jasminum auriculatum Vahl	Rajura.
Nyctanthes arbor-tristis Linn.	Lakkadkot.
Schrebera swietanioides Roxb.	Tamurda.
Apocyaaceae	
Holarrhena antidysenterica (Roth) A. DC.	Sondo (Rajura).
Ichnocarpus frutescens (Linn.) R. Br.	Rajura.
Rauwolfia serpentina (Linn.) Benth. ex Kurz.	Chandrapur.
Wrightia tinctoria R. Br.	Tadoba.
W. tomentosa Roem. and Schult.	Dhaba.
Asclepiadaceae	
Cryptolepis buchanani Roem. and Schult.	Elgurtola.
Dregea volubilis (Linn. f.) Benth. ex Hook. f.	Nagbhir.
Gymnema sylvestris R. Br.	Mesa.
Hemidesmus indicus (Linn.) Schult.	Chandur.
Holostemma annulare (Roxb.) K. Schum.	Ettapalli (Bhamragadh).
Oxystelma esculentum R. Br.	Wainganga (Ballarpur).
Pergularia daemia (Forsk.) Chiov.	Ghantachowki.
Sarcostemma acidum (Roxb.) Voigt.	Lakkadkot.
Tylophora fasciculata Ham.	Ghodejhari (Nagbhir).
Loganiaceae	
Strychnos nux-vomica Linn.	Sironcha.
S. potatorum Linn.	Kanhargaon.
Gentianaceae	
Canscora diffusa R. Br.:	Lakkadkot.
Enicostema hyssopifolium (Willd.) C. B. Rob.	Rajura.
Exacum pedunculatum Linn.	Manekshahgadh.
E. pumilum Griesb.	Katejhari (Tadoba).
Hoppea dichotoma Willd.	Dechali.
Nymphoides cristatum (Roxb.) O. K.	Dechali.
Hydrophyllaceae	
Hydrolea zeylanica (Linn.) Vahl.	Bamni (Sironcha).
Boruginaceae	
Coldenia procumbens Linn.	Dechali.
Cordia dichotoma Forst. f.	Keslaghat.
C. macleodii Hook.	Vadasa.
Heliotropium indicum Linn.	Dechali.

Name	Locality
Rotula aquatica Lour.	Somanpalli.
Trichodesma indicum R. Br. .. Var. *amplexicaule* Cooke.	Ghantachowki.
Convolvulaceae	
Argyreia strigosa (Roth) Sant. et Patel.	Chandur.
Ipomaea aquatica Forsk. ..	Aheri.
I. pes-tigridis Linn.	Moharli.
I. quamoclit Linn.	Tamurda.
I. sepiaria Koenig ex Roxb. ..	Aheri.
Jacquemontia paniculata (Burm. f.) Hall. f.	Pandarpani side (Tadoba).
Merremia emarginata (Burm. f.) Hall. f.	Chandur.
M. tridentata (Linn.) Hall. f. ssp. *angustifolia* (Jacq.) Van Dost.	Jamni side (Tadoba).
Solanaceae	
Datura fastuosa Linn. var. *alba* C. B. Clarke.	Nagbhir.
Physalis minima Linn.	Mesa.
Scrophulariaceae	
Bacopa hamiltoniana (Benth). Wettst.	Dechali.
B. monnieri (Linn.) Pennell ..	Chandrapur.
Limnophila aquatica (Roxb.) Alston.	Manekshahgadh.
Scoparia dulcis Linn.	Somanpalli.
Sopubia delphinifolia (Linn.) G. Don.	Warora.
Stemodia viscosa Roxb.	Vadasa.
Striga angustifolia (D. Don.) Saldanha.	Ghantachowki.
Lentibulariaceae	
Utricularia scandens Benj. Var. *scandens* P. Taylor.	Brahmapuri.
Dolichandrone falcata seem var. falcata.	Lakkadkot.
Heterophragma quadriloculare (Roxb.) K. Schum.	Lakkadkot.
Stereospermum personatum (Hassk.) Chatt.	Porla.
Pedaliaceae	
Pedalium murex Linn.	Junona.
Martyniaceae	
Martynia annua Linn.	Manekshahgadh.
Acanthaceae	
Adhatoda vasica (Linn.) Nees ..	Mercacasa (Bergaon).
Andrograhis echioides Nees ..	Lakkadkot.
A. paniculata (Burm.) Wall. ex Nees.	Rajura.

Name	Locality
Barleria cristata Linn.	Manekshahgadh.
B. prionitis Linn.	Kistapur.
Blepharis maderaspatensis (Linn.) Heyne ex Roth.	Kistapur.
B. repens (Vahl) Roth	Kanhargaon.
Haplanthus verticillatus (Roxb.) Nees.	Manekshahgadh.
Lepidagathis cristata Willd. ..	Lakkadkot.
L. trinervis Wall. ex Nees ..	Chaudampalli.
Peristrophe bicalyculata (Retz.) Nees.	Ghantachowki.
Petalidium barlerioides (Roth). Nees.	Vadasa.
Ruellia tuberosa Linn.	Chandrapur.
Verbanaceae	
Clerodendrum multiflorum (Burm. f.) O. Kuntze.	Manekshahgadh.
C. serratum (Linn.) Moon ..	Elgurtola.
Duranta repens Linn.	Rajura (Planted).
Lantana camara Linn. .. var. *aculeata* (Linn.) Moldenke.	Lakkadkot.
L. indica Roxb.	Dechali.
Phyla nodiflora (Linn.). Greene ..	Lakkadkot.
Tectona grandis Linn.	Ghantachowki.
Vitex negundo Linn.	Lakkadkot.
Lamiaceae:	
Anisochilus carnosus (Linn.) Wall.	Jamni side (Tadoba).
Anisomeles heyneana Benth. ..	Aheri.
Leonotis nepotifolia (Linn.) Ait. f.	Manekshahgadh.
Leucas cephalotes Spreng. ..	Lakkadkot.
L. stricta Benth.	Tadoba.
L. zeylanica R. Br.	Lakkadkot.
Nyctaginaceae	
Boerhavia chinensis (Burm. f.) Asbhers. et Schew. f.	Manekshahgadh.
B. diffusa Linn.	Ghantachowki.
Amaranthaceae	
Aerua lanata (Linn.) Juss. ..	Ghantachowki.
Digera muricata (Linn.) Mart. ..	Lakkadkot.
Chenopodiaceae	
Chenoiodum album Linn. ..	Chandrapur.
Polygonaceae	
Polygonum barbatum Linn. .. var. *gracile* (Dans.) Steward.	Kurkheda.
P. glabrum Willd.	Maseli (Bergaon).
P. plebeium R. Br.	Ashti.
Rumex vesicarius Linn.	Chandrapur (Cultivated).
Aristolochiaceae	
Aristolochia indica Linn. ..	Wamanpalli.
Lauraceae	
Cassytha filiformis Linn. ..	Lakkadkot.

Name	Locality
Loranthaceae	
Dendrophthoe falcata (Linn. f.) Etting.	Chandur.
Viscum articulatum Burm. ..	Karva (Ballarpur).
V. nepalense Spreng.	Maseli (Bergaon).
Euphorbiaceae	
Acalypha ciliata Forsk.	Warora.
A. indica Linn.	Ghantachowki.
A. malabarica Muell. Arg. ..	Bamni (Ballarpur).
Baliospermum montanum Muell. Arg.	Kanhargaon.
Bridelia hamiltoniana Wall. ..	Dechali.
B. retusa (Linn.) Spreng. ..	Kistapur.
Cleistanthus collinus Benth. ..	Manekshahgadh.
Chrozophora prostrata Dalz. ..	Vadasa.
C. rottleri (Geis.) Juss. ex Spreng	Chandrapur.
Euphorbia elegans Spreng. ..	Manekshahgadh.
E. geniculata Orteg.	Tadoba.
E. parviflora Linn.	Ghantachowki.
Homonoia retusa Muell. ..	Ashti.
H. riparia Lour	Kurkheda.
Mallotus philippensis (Lamk.) .. Muell. Arg.	Somanpalli.
Phyllanthus asperulatus Hutch. ..	Nagbhir.
P. lawii Grah.	Wamanpalli.
P. maderaspatensis Linn. ..	Mesa.
Tragia cannabina Linn. ..	Chandur.
Ulmaceae	
Holoptelea integrifolia (Roxb.) Planch.	Brahmapuri.
Urticaceae	
Distemon indicum Wedd. ..	Chaudampalli.
Fleurya interrupta (Linn.) Gaud.	Alapalli.
Streblus asper Lour.	Dhaba.
Moraceae	
Ficus amplissima J. E. Sm. ..	Aheri.
F. arnottiana Miq.	Wamanpalli.
F. asperrima Roxb.	Alapalli.
F. tinctoria Forest f.	Vadasa.
F. parasitica Corner. Var. *parasitica* Corner.	
Casuarinaceae	
Casuarina equisetifolia J. R. and G. Forst.	Chandrapur.
Orchidaceae	
Habenaria commelinifolia Wall ex Lindl.	Khatoda side (Tadoba).
H. plantaginea Lindl.	Alapalli.
Vanda tassellata (Roxb.) Hook ex G. Don.	Ghantachowki.

Name	Locality
Zingiberaceae	
Costus speciosus (Koenig) Smith	Elgurtola.
Curcuma pseudomontana Grah.	Reghevahi (Ghot).
Hypoxidaceae	
Curculigo orchioides Gaertn. ..	Ghantachowki.
Amaryllidaceae	
Crinum defixum Ker-Gawl. ..	Chaudampalli.
Taceaceae	
Tacca leontopetaloides (Linn.) O. Kuntze.	Tukumpalli (Allapalli).
Dioscoreaceae	
Dioscorea bulbifera Linn. ..	Brahmapuri.
D. pentaphylla Linn. ..	Khatoda (Tadoba).
Liliaceae	
Asparagus racemosus Willd. ..	Kanhargaon.
Gloriosa superba Linn. ..	Mcsa.
Iphigenia indica (Roxb.) A. Gray. ..	Khatoda (Tadoba).
Urginea indica (Roxb.) Kunth ..	Kukdel (Bergaon).
Smilacaceae	
Smilax zeylanica Linn. ..	Elgurtola.
Pontederiaceae	
Monochoria vaginalis (Burm. f.) Presl ex Kunth.	Aheri.
Xyridaceae	
Xyris pauciflora Willd. ..	Bamni (Sironcha).
Commelinaceae	
Amischophacelus axillaria (Linn.) Rolla Rao et Kammathy.	Garlapeth (Wirur).
A. cucullata (Roth) Rolla Rao et Kammathy.	Rajura.
Commelina diffusa Burm. f. ..	Aheri.
Murdannia nodiflora (Linn.) Brenan.	Aheri.
Palmaceae	
Borassus flabellifer Linn. ..	Jimalagatta (Planted).
Caryota urens Linn.	Wirur (Planted).
Phoenix humilis Royle	Maseli (Bergaon).
Typhaceae	
Typha angustata Bory and Chaub.	Naleshwar.
Alismataceae	
Limnophyton obtusifolium (Linn.) Miq.	Lakkadkot.
Butomataceae	
Tengagocharis latifolia (D. Don.) Buchen.	Dhanora.

Name	Locality
Aponogetonaceae	
Aponogeton natans (Linn.) Engl. and Krause.	Mul.
Najadaceae	
Najas indica (Willd.) Cham. ..	Dechali.
Eriocaulaceae	
Eriocaulon dianae Fyson ..	Ghodejhari.
Cyperaceae	
Bulbostylis barbata Kunth ..	Dechali.
Cyperus difformis Linn. ..	Aheri.
C. rotundus Linn.	Aheri.
Eleocharis atropurpurea Kunth ..	Chandrapur.
E. capita R. Br.	Chandrapur.
Fimbristylis littoralis Gaud ..	Ghantachowki.
Fuirena glomerata Lamk. ..	Keslaghat.
Poaceae	
Andropogon pumilus Roxb. ..	Lakkadkot.
Apluda mutica Linn.	Lakkadkot.
Aristida adscensionis Linn. ..	Rajura.
Arthraxon echinatus (Nees) Hochst.	Khatoda (Tadoba).
Arundinella pumilla (Hochst.) Steud.	Wamanpalli.
Bothriochloa intermedia (R. Br.) A. Camus.	Elgurtola.
B. pertusa (Linn.) A. Camus ..	Jamni (Tadoba).
Coix gigantea Koenig ex Roxb. ..	Pandarpani (Tadoba).
C. lacryma-jobi Linn. var. *lacryma-jobi*.	Ghantachowki.
Cymbopogon martinii (Roxb.) Wats.	Rajura.
Dactyloctenium aegyptium (Linn.) P. Beauv.	Ghantachowki.
Dendrocalamus strictus (Roxb.) Nees.	Kanhargaon.
Dichanthium annulatum (Forsk.) Stapf.	Aheri.
Echinochloa colonum (Linn.) Link	Rajura.
E. crusgalli (Linn.) P. Beauv. var. crusgalli.	Wainganga (Ballarpur).
Iseilema prostratum (Linn.) Anderss.	Gomni.
Oryza rufipogon Griff. ..	Rajura.
Panicum maximum Jacq. ..	Gadhchiroli.
P. miliars Lamk.	Nagbhir.
P. montanum Roxb.	Somanpalli.
P. psilopodium Trin.	Armori.
Paspalidium flavidum (Retz) A. Camus.	Wamanpalli.
Paspalum scrobiculatum Linn. ..	Mulchera.
P. polystachyon (Linn.) Schult.	Tadoba.
P. purpureum Schumach ..	Lakkadkot.
Setaria glauca (Linn.) P. Beauv.	Warora.
S. tomentosa (Roxb.) Kunth ..	Ghantachowki.
Themeda quadrivalvis (Linn.) O. K.	Ghantachowki.

Name	Locality
Thelypteridaceae	
Cyclosorus parasiticus (Linn.) Farwell. ..	Bamni (Sironcha)
Adiantaceae	
Adiantum incisum Forsk. ..	Lakkadkot.
Aleuritopteris albo-marginata (Clarke) Panigrahi. ..	Wamanpalli.
Cerotopteris thalictroides (Linn.) Brongn.	Katejhari side (Tadoba).
Marsileaceae	
Marsilea minuta Linn. ..	Ballarpur.

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CHAPTER VII—FLORA OF KONKAN

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CHAPTER VII—FLORA OF KONKAN

1. Introduction :

Maharashtra comprises four regions, *viz.*, Konkan, Western Maharashtra, Marathwada and Vidarbha ; but geographically it comprises only two parts *viz.*, Konkan and Desh separated by the long ranges of Sahyadris running almost parallel to the Western coast of India. Konkan is a small narrow strip 27 to 48 km broad and about 800 km long from Goa to the Tapi basin. It is a distinct botanical sub-unit of Malabar province lying in continuation with it. It is a maritime province with high humidity throughout the year, not less than 60 per cent to 70 per cent any time. The vegetation, therefore, is green throughout the year, but the hills are barren. On the west side Sahyadri ranges are highly precipitous and form escarpment several metres in height ; *e. g.* near Amboli village at Tombyachi Wadi, the escarpment is a straight drop of more than 30—38 metres, and a similar situation is there throughout these ranges. The ranges rise high from 518—915 metres at places. They are undulating but not rugged and the peaks are flat-topped. The average height of Konkan plain is hardly 6—9 metres above the mean sea level. But the summits of Mahabaleshwar and Harischandragad are above 1220 metres. Naturally the wall of these ranges on the Western side serves as a watershed. It obstructs the clouds coming with South West monsoons and get intercepted by *ghats* or passes from West to East. The rainfall at the foot of Sahyadris on the Konkan side, on an average, is 2286 mm—2540 mm., but less in the coastal region. The Konkan is broadly a plain surface formed by the denuded debris and laterite from the Western *ghats* and some alluvium brought by the fast moving rivers and streams and deposited in depressions and valleys. The streams are generally bunded along their courses right down to their mouth opening into the Arabian sea. A series of terraces are formed of alluvial soil. The coastal strip of 15 to 17 km. is a marshy saline bed due to incursions of the sea. It encourages only salt tolerant plants ; but the plains behind are heavily cultivated with rice, ragi and such other crops and vegetables. But where the deposit is a rich alluvium, coconut, betel-nut, mango, nutmeg, cashew are planted between Alibag, Ratnagiri, Sawantwadi and Goa.

At the foot of the mountain there are generally marshy conditions in rainy season ; but as soon as the rainy season is over they vanish, as the water flows away rapidly in torrents to sea, and the soil becomes nearly dry on account of its lateritic nature. In contrast to this, on the eastern side of the Western *ghats* or Sahyadris, there is a gentle slope and deep ravines on Desh side. Rivers small and large bring rich detritus material from the traps to the valleys. Below and through them, the rain water flows slowly enriching the riverbanks and valleys on the Desh side. At several places, there are lateral spurs of Sahyadris separated from each other, creating conditions of high humidity and good drainage, as in the '*Sholas*' of Nilgiris, or like those in Khari hills of Assam. These are the Mavals. They are fertile where soil is accumulated.

Konkan comprises the five districts of Thane, Raigad, Sindhudurg, Ratnagiri and Greater Bombay. There is no comprehensive account of the Flora of Konkan despite the fact that according to Hooker and Thomson (1855) Konkan is a part of Malabar botanical sub-province of India. Several distinguished botanists such as Dalzell and Nairne had resided there. As a matter of fact Dalzell was staying at Thane for a long time. Similarly Rev. Father Blatter, Father H. Santapau, Almeida,

McCann were staying at Bombay. But it was only Cooke (1903—1908) who examined all the material then available and gave a fairly good account of plants in this region as were known till that time. After that, Blatter and McCann revised several families of the Bombay Presidency and added about 30 new species to the flora. Similarly Santapau and his students have also revised many families of Bombay Flora and added some new species to it. All this new material, however, has not been incorporated in any book on Flora and, therefore, we have to be guided mainly by the Cooke's account of the flora of the above mentioned coastal districts.

The Flora of Thane has recently been described in a thesis by Bilore (1972), but it is not published. He has described 105 families, 572 genera, 989 species in Thane district, improving upon the Cooke's list. As regards Greater Bombay, the position is the same ; but there are very many references to the plants of Bombay and Salsette Island in Cooke's flora.

The Flora of North Bombay is richer than the Flora of South Bombay. It is enlisted by Santapau and G. L. Shah (1970). This list contains many species spread over 109 families. These are the same as are found in North Bombay, but there are many cultivated plants added. Prof. P. V. Bole and his student Miss Randeria have written on the Gamopetalous Phanerogams of Krishnagiri National Park, Borivali. A taxonomic study of monocots of Krishnagiri National Park is made by R. R. Fernandes *et al* (1954). A third account of Polypetalae and Apetalae of the Krishnagiri National Park, Borivali, is given by P. S. Herbert. G. L. Shah has written a thesis on the Flora of Salsette Island (Ph. D. thesis, 1965) submitted to the Bombay University. For reference to the plants of Bombay and Salsette Islands we have to fall back on Cooke and the Flora of Salsette Island (Malad and Madh area) by Santapau and Shah (1970).

The flora of Raigad district was particularly studied by Santapau with reference to Matheran and neighbourhood. The Hon. Justice Birdwood had written on the same after the middle of the last century. The Flora of Ratnagiri had remained mostly undescribed. The flora of North Ratnagiri is quite similar to that of Bombay, Raigad and partly Thane. The flora of South Ratnagiri has more humid species as in Goa, North Kanara and Malabar. Dr. B. G. Kulkarni has made a study of it which is referred in this book. The flora of Sawantwadi and Goa has been described by a brilliant botanist, Surgeon Dalgado (1896). He was much interested in plant introduction and used to bring a number of plants from Sri Lanka and grow them in Sawantwadi area. The cultivation of pepper, cocoa (*Theobroma cocoa*) here is largely due to his efforts. Dalgado's list has been improved upon by more recent list by Dr. V. D. Vartak (1966) in his *Enumeration of the Plants of Goa and Sawantwadi*, and by Dr. B. G. Kulkarni (1979). Since these are more up-to-date lists, they are used here selectively.

Besides these regular works on the flora of Konkan, there are a few stray references to its plants in Van Rheede's *Hortus Indicus Malabaricus* (1678) and *Forest Trees* by Talbot (1909). Several other workers have described the plants in their research papers. Two significant areas Raigad and Kanakeshwar are described floristically : Raigad by Vartak (1966) and Kanakeshwar by A. N. Namjoshi and quoted by Ezekiel (1947) in his *Plant Sociology* Part II, pp. 123—128. We shall summarise our observations on each of these floras, separately.

The canopy is formed by some dominent plants such as *Mangifera indica, Saraca indica, Bauhinia vahlii,* besides *Sterculia colorata* (*Firmana colorata*), *Grewia microcos, Ixora coccinea.* The second stratum is formed by some climbers and shrubs like *Cocculus villosus, Gardenia lucida, Symphorema involucrata, Dioscorea pentaphylla.* The herbacious growth consists, especially in rainy season, of *Ageratum conyz oides, Barleria prionitis, Daedalacanthus purpurascens, Anogeissus latifolia,* a mixture of both dry and moist species. The climbers are *Pueraria tuberosa, Capparis sepiaria* and *Clematis hedysarifolia.*

On the Wagreshwar plateau we get mostly the dry and strand plants *e.g. Erythrina indica, Bridelia stipularis, Bridelia hamiltoniana, Anacardium occidentale, Ixora nilgirica Ixora, coccinia, Zizyphus rugosa* and *Zizyphus oenoplia.* These are the plants which are also seen in the forests of Jawhar, Borivali, Dahisar etc. One has to note however there are no strictly evergreen trees which occur in patches in the South Konkan or in a continuous belt in North Kanara, or in Mysore forests.

2. History of Konkan Flora :

Plants of Konkan had attracted attention of botanists since long. Some of them are mentioned in the "*Os Colloquiosd' Drogas Simpleles*" of Garcia de Orta (1565) and also in Henrik van Rheedes' *Hortus Indicus Malabaricus* (1678-1690), now nearly 300 years old. But the systematic study of Konkan plants began with Graham (1839) who listed them in his well known *Catalogue of Bombay Plants* assisted by Nimmo. Both Graham and Nimmo were regularly corresponding with Dr. Wight at Kew. Some of their sheets are in Kew Herbarium. Roxbourgh (1820), Brandis (1921), Hooker (1872-1897) have also mentioned them, but the real systemetic study of them was done by two enthusiastic Conservators of Forests in Bombay, Dr. Gibson and Dalzell. Their collections are also in Kew herbarium. When Dr. Gibson went on leave to Europe, Dr. Stocks officiated for him as Conservator of Forests and continued his work. Dalzell, Gibson, Law were energetic collectors of Konkan plants. Law largely concentrated on the plants of Northern Konkan and Bombay, while Dalzell chiefly engaged himself with the collections on plants of Southern Konkan and North Kanara. Talbot (1909), Wight and Arnott (1834) have given figures of many trees in Konkan in their works.

Throughout Konkan, there are depressions either caused by fast moving water courses and rivers, tactonic movements and by changes in the sea level. Due to them, the continuity of the Sahyadri mountains and also of the plains get interrupted at many places ; the rain water falling runs straight to the Arabian sea. The water courses and rivers are fast moving. Due to them there are many creeks. Some Sahyadri ranges, though short, run straight into sea. Their banks are covered with alluvium brought from Sahyadris. It is washed away completely in many places and the hill tops are barren, or are covered with light shallow lateritic soil. In some cases, there is good vegetation but only in a few places. It is varied in point of species and genera. The vegetation, therefore, is mostly near the foot of the mountain ranges. On the plains, there are only cultivated fields on soil artificially built by stone bunds.

The sea coast and creeks are covered with rich mangrove vegetation and show zonation depending upon the amount of salt contained in the soil.

Generally, the Northern Konkan dries early compared to the South Konkan, which is humid and more or less like Goa and Malabar. For example, Sawantwadi is more like Goa than like Bombay or Northern

Konkan. Rivers Ulhas, Vashishthi, Kundalika, Shastri, Urahi, Gad, Ter, as they go to sea, deposit rich alluvium on the banks and in depressions. There is not much of salt in esturian soils as it is annually leached out by rains and river waters. There are good many orchards of coconut, betelnut or mango on their banks in *wadis*. In between the two Konkans, there are certain areas like Jayagad which are rocky, stony and dry. The vegetation there is much scruby. Nothing grows there except mango trees. There are small islands near the coast of Konkan. They have been investigated by Dr. Untwale under Dr. Mahabale's supervision, but he has not published any account of them. We shall, therefore, give the list of flora of Ratnagiri and Sindhudurg districts and of Thane as representatives of the two areas of Konkan till a fuller account of them is available.

The lists of plants of Konkan especially Sawantwadi including those mentioned by Dalgado, Plants of Greater Bombay district, and lists of plants of mountain tops of Sahyadris like Matheran of Raigad and other areas in the region are given separately.

3. Climate of Konkan

The climate of all the districts in Konkan is maritime, humid throughout the year. Rainfall is regular; coastal areas are cooler than interior which gets more rain than coastal areas. At the foot of the *ghats* rains are heavy.

District Thane :

The climate is characterised by high humidity nearly throughout the year, and in summer by moist heat, which is oppressive. Rainfall is heavy and well distributed during S. W. monsoon season. Cold season is December to February. Summer season is March to June. Monsoon lasts from June to September, October and November are post-monsoon period.

Rainfall.—Average annual rain fall is 2293.4 mm. (90.29″). It increases from coast towards the interior and varies from 1730.5 mm or 68.13″ to 90″ at Mahim. It is 2588.51 mm (104″) at Shahapur in the interior. It lasts from June to September, July is the rainiest month with 40 per cent of the total rain falls in this month. Variation from year to year is not much. The number of rainy days are 83-84. It varies from 67 at Mahim on the coast to 92 at Thane. In 1958, Dahanu had the highest rains. In 1958 on 1st September it was 481.1 mm (18.94″) in 24 hours.

Temperature.—Near coast temperatures are little higher than in the district. At Dahanu they are lower in cold season and higher in hot season. Day and night temperatures do not vary much. After February till May, they progressively increase, the hottest month being May. In May daily mean maximum temperature is 32.9°C (91.3°F). Before the onset of rains temperature rises to 37°C (98.6°F) in the coastal parts. In the interior this may be more and the heat oppressive. It is less on the coast. The thunder storms appear in May. From the beginning of November the temperature goes down, but in October and November again rises but not as much as summer. The coldest month is January having mean daily maximum temperature 27.7°C (81.9°F). Mean daily minimum then is 16.8°C (62.2°F). Cold waves sometimes

affect weather when night temperature goes down to 10°C. The highest temperature recorded at Dahanu was 40.6°C (105°F) in April 1955 and the lowest 8.3°C (46.9°F) on 8th January 1945.

Humidity.—Throughout the year, except during monsoons, the sky is clear or lightly clouded. Winds are moderate. During monsoon they are strong. In pre-monsoon period cyclonic storms in Arabian sea move in northerly direction during the latter part of summer and in post-monsoon period, affecting the coastal areas. Wind sometimes reaches a gale force on the coast with thunder and storm in late summer and in October.

District Raigad :

Climate of this district is typical of the west coast of India. Summer is March to May; June to September is rainy. October and November are post-monsoon period or of retreating monsoon. December to February are cold.

Rainfall.—S. W. monsoon begins in the first week of June and continues till the beginning of October. Average rainfall for the district is 3028.9 mm (121.25″). It rapidly increases from coast towards Western Ghats, which form the eastern border of this district. On the coastal plain it decreases towards north. Uran and Alibag on the coast at northern end get annually 2072.3 mm (83.58″) and 2080.8 mm (83.92″) rain, respectively. Matheran on the *ghats* gets 5167.5 mm (206.45″). October is the rainiest and so also July, but less than October. Very rarely in 55 years, it is either more or much less. Annual rainfall for the district for 50 years is 2600 to 3600 mm (104.36″ to 144·73″). The number of rainy days is 94. They are 82 at Uran and Alibag and 108 at Matheran.

Temperature.—Diurnal and seasonal variations are not much Temperature increases from March to May. May is the hottest, with mean daily maximum temperature 31.7°C (89.1°F). Daily minimum is 26.4°C (79.5°F). Breezes are there even in summer months. Temperature comes down with monsoons; towards September, October and November weather is like that of summer. December to February are cool. Air is humid throughout the year. On an average, humidity is 80 per cent in S. W. monsoons. In rest of the year relative humidity varies from 65 to 75 per cent. In May and October, there are light clouds. But in rainy season, the sky is heavily clouded. Winds are moderate from January to March. In April they become strong but variable in direction. From May they blow S. W. to N. E. Cyclonic storms occur in post-monsoon period and to a small extent in May. In the coastal area they bring heavy rains and thunder storms in April and May.

Greater Bombay :

Rainfall.—The moist heat and summer are oppressive from March to November. Heavy S. W. monsoon begins in the 1st week of June. December to February is cold season. March to June is summer. June to September is rainy season. October and November is post-monsoon period. Average annual rainfall is 1917.3 mm. (79″). There is not much variation in rain in Greater Bombay, but pattern of rainfall for individual days is not uniform. In some places it is very heavy and at others it is much less. Variation from year to year is noticeable. In 50 years annual

rainfall is less for 2-3 years and less than 80 per cent of the normal for 10 years. Rainfall is due to S. W. monsoon. July is rainiest having 1/3rd of annual rainfall. Some of it occurs with thunder storms in May and June and in post-monsoon months. The rainfall varies from 1700 mm to 2300 mm in 26 years out of fifty. Average rainy days are 73.

Temperature.—Santacruz is slightly warmer than Colaba at the sea coast. Nights are colder at Santacruz in cold season. Temperature goes on increasing after February till May, the hottest month. The mean daily maximum temperature in May is 33.3°C (91.9°F) at Colaba, and 33.3°C (91.9°F) at Santacruz. The mean daily minimum temperature in May is 26.9°C at Colaba and 26.2°C at Santacruz. Due to high humidity throughout the year, particularly in summer, weather is oppressive. Sometimes maximum temperature goes to 40°C (104°F). But sea breezes lessen heat. After the advent of monsoon in June, weather becomes cool. Towards the end of south-west monsoon, the day temperatures rise slightly and a secondary maximum is reached in November. Nights become cool after the monsoon. After November day temperature decreases. January is the coldest month. Daily mean maximum is 29.1°C at Colaba, and 30.6°C (87.1°F) at Santacruz. The mean daily minimum temperature is 19.4°C (66.7°F) at Colaba, and 16.3°C at Santacruz. In the cold season, due to weather disturbances mean temperature drops to 10°C (50°F). The highest temperature recorded at Colaba in April 1955 was 40.6°C (105.1°F), and at Santacruz was 42.2°C (108°F) in the middle of April 1952. Lowest minimum at Colaba was 11.7°C (53.1°F) on 15th January 1935, when at Santacruz it was 7.4°C on 22nd January 1962. Colaba experiences more humidity than Santacruz. Mornings are more humid than noon in Bombay. In June to October relative humidity is 75 per cent and above. During November and February the relative humidity is 50—65 per cent in the afternoon which is the driest part of the year. In monsoons the sky is heavily clouded, but not so afterwards. During December to March it is clear or lightly cloudy. Cloudiness increases with the progress of S. W. monsoon season. Winds are moderate in monsoon but heavy before blowing S. W. to N. E. In the latter part of the summer, in post-monsoon period storms occur due to depressions in Arabian sea, with heavy rainfall and gusty winds. Thunder storms are not uncommon in September and October associated with rain.

Ratnagiri and Sindhudurg Districts[1] :

Rainfall.—Climate of the two districts is moist but relaxing and healthy. Rainfall is regular and plentiful. Seasons are usual as elsewhere. But the rainfall at different places is quite different. At Amboli at the foot of Western Ghats it is twice as much as in other parts of the districts. Therefore, it is difficult to know representative average for the whole of districts, except at the foot of Ghats. Average annual rainfall has been calculated at 3188 mm (127.52"). It increases rapidly towards the Ghats on the eastern border of the districts. Rains near the Ghats are very heavy, *e. g.*, at Amboli which gets on an average 7446.00 mm of rain. The coastal places such as Malwan and Deogad get 2155 mm and 2247 mm rain, respectively. The rainiest month is July, when more than 1/3 of the rain falls. The annual mean rainfall varies between 2600 and 3800 mm. The number of rainy days is 101. At Dapoli sometimes rain is heavy in June.

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1. Ratnagiri was divided into two districts, namely, Ratnagiri and Sindhudurg, in 1981.

Temperature.—It rises from March to May. May is the hottest, but it drops by 3-4°C with the onset of rains. It again increases from October to November. Day temperature is usually lower. November is as hot as May. Night temperature is lowest in January, 20—25°C. Nights are pleasant even in the hot months, but in the interior the weather is oppressive particularly at foot of the Ghats. Maximum temperature along the coast seldom goes beyond 38°C (100.4°F), but in the interior it may reach 40°-41°C (104°F-106°F). Due to proximity of sea the weather is humid throughout the year. In winter humidity goes below 50 per cent. The sky is clear except in monsoons when it is highly cloudy. Winds move in S. W. direction and are quite strong and move in the opposite direction from North and East in the mornings in other months. After monsoon period, they blow West and N. W. The district experiences very strong winds and gales with cyclonic storms, and heavy rains in the coastal areas, as they develop in Arabian sea. Thunder storms are common in post-monsoon period.

4. Soils of Konkan :

Most of the soils in Konkan are leached lateritic and reddish. They are originally derived from Deccan traps but due to heavy rainfall and fast moving streams within a short distance they get thoroughly leached out. They contain dehydrated iron oxides which impair red colour to them having various shades of red or brown colouration. Even the silicic acid and calcium salts are washed away by the heavy rains, including silicon sequioxide. They contain some nitrogen but practically no lime. They have very low retentivity of water, otherwise they are good. They are very suitable for horticultural crops like mango, cashew, coconut, areca, chikku, pineapple, vegetables, etc. They are hardly 0.304 to 0.914 metres deep and not much fertile. But they are not sticky, and have good aeration. The crops of nagli, sava, and vari grew well. They need to be provided with nitrogen and lime. A new project for urea and nitrogen fertilizers is being set up at Thal Waishet near Alibag.

Along the river banks and near estuaries the soils are alluvial and fertile. Near the sea coast and on tops of hills soils called *Mal* are poor or '*Varkas*'. At Dapoli, Rajapur, Ratnagiri and Guhagar the soils near the sea coast are deposited with deep sandy loam. They are recent deposits. They have not been fully matured and hence look yellow.

5. Vegetation of Konkan

Starting from the coast, the vegetation may be described as follows :

All along the coast line, there are tidal swamps and mud flats mostly covered by mangroves. Behind them are the sand binders and strand forests, but not everywhere. They occur especially where the soils are sandy and the coast is not muddy. There are semi-evergreen forest pockets containing teak (*Tectona grandis*) and tall woody creepers mixed with tropical species. There are a few pockets of evergreen forests in Sindhudurg but nowhere they are continuous, or form zone of evergreen forest.

On the hill side towards west there are dry deciduous forests of *Tectona grandis* (Teak) ; but the teak is of poor type not having large size. On the Sahyadri ranges, the forests are not very thick. They are of the dry deciduous type. The pockets of tropical evergreen and semi-green species are more in South Ratnagiri, the richest area being Sawantwadi next to Union Territory of Goa. They have moist deciduous forests.

Near estuaries of streams and river banks there are tidal forests of mangroves and other species. The palm Coconut, *Cocos mucifera* fringes behind the coastline. Palmyra *Borassus flabellifer* grows on low hills and forms skyline. At places like Revdanda, Alibag, Vasai, *Hyphaene indica* grows in patches. In Thane district *Phoenix sylvestris* occurs near *wadis* e. g. at Dahanu, and *Areca catechu* at Uran, Pule, Dive Agar, etc.

The Flora of Kanakeshwar is typical of the vegetation in Konkan. On the top of Sahyadri hills and on slopes there are typical dry deciduous forests. However the hill passes from Konkan to Desh such as Amba, Amboli are rich in varied vegetation. They are a treasure of various interesting species of practically all groups. They represent, in part, ancient vegetation in this region as they contain some rare and endemic species as well as moist deciduous species.

Thane :

Reference to Thane plants has been made by Dalzell (1850—52), Dalzell and Gibson (1861), Nairne (1894), Cooke (1901—1908) and others. The flora of Thane district has been recently studied by Bilore (1972), but his work is unpublished. Only general account of angiosperms is given here.

Thane forests abound in good teak (*Tectona grandis*) and *Adina cordifolia*. The trees are fairly tall ; vegetation is of mixed deciduous type , we do not get any evergreen species. During monsoons a very distinctive ephemeral flora appears and also disappears quickly. It is of the same nature as the monsoon ephemeral flora elsewhere ; however it is richer in species. It appears on the mountain tops, flats, slopes, and plateaus formed by the successive erosion of the trap layers. These species quickly germinate and form thick compact stands and cushions. They form seeds and disperse them in a short time. After the seed dispersal they disappear abruptly. Their list is given separately. They are very conspicuous on Tungarli hills and outer ranges of Kosbad hills.

Another important part in the vegetation of Thane district is that of conserved grasslands. These grasslands are mainly preserved for cattle fodder. They consist of edible grasses. They grow in a belt from Raita, near Kalyan, Bhivandi to Palghar, Dahanu, Umbergaon and continue beyond Vapi in southern Gujarat. They lie in a narrow strip of land at the foot of low hills of Sahyadri ranges facing sea. Conditions for the growth of grasses are optimum and hence the grass produced is plentiful. Side by side with them some tall grasses like *Themeda triandra* also grow, but their proportion is relatively small. It is with the help of these fodder grasses that the Dapchari Milk Scheme has been planned in Thane districts. It is however necessary to remark that these are not the real grasslands like Prairies or Steppes. They are man-made grasslands or '*Kuran*'.

The third type of vegetation in Thane is that of shore plants and sand plants. Muddy shore plants or mangroves are nearly the same as in Bombay Island, but the sea shore in the northern part of Thane district is sandy. Many sand binding plants grow freely. Among them is a very noteworthy grass *Spinifex squarrosus*.

The fourth type of vegetation in Thane district is of the monsoon deciduous teak forest. However as there is no comprehensive flora of Thane district published, we have to study it with the help of whatever is

published. Many rivers cross Thane district and go to Arabian sea. The river banks are full of mangroves. The marshy areas are not much saline.

Recently Dabhade (1966) has published a list of flora of Ulhasnagar near Kalyan. Much of it is on the river bank.

It will be seen that it is of the same type as in other districts of Konkan.

The well-known hot water springs at Vajreshwari are in Thane district. Their algal flora has been worked out by Prof. Mrs. E. Gonzalves (1947).

Raigad :

The flora of this district also is not worked out, but of Matheran and Raigad hill fort has been described by Birdwood (1886), Cooke (1901—1908) and of Raigad by Vartak (1966). Matheran is a plateau, not very extensive nor very broad, hardly a mile wide and three miles long. It abruptly ends on the southern side at Jacob's Ladder looking toward the Duke's nose. It forms a precipitous slope on the western side facing sea. It is quite rich in vegetation and contains about 140 flowering plants excluding grasses, ferns and mosses. There are as many as seven species of *Strobilanthes* noticeable from foot to the top of this isolated hill, about 620 metre high. The forest on the top is rather stunted and is of the monsoon deciduous type, green in monsoons but dry after rains for the most part of the year. There are many deciduous species along with some moist deciduous species, such as *Garcinia indica*, several ferns and mosses, bushes of *Ligustrum nilgirense*, *Salix tetrasperma*, *Glochidion hohenckeri*, *Flacourtia montana*, *kydia calycina*, *Artocarpus insigne*. They form the canopy. They mostly grow in depressions and valleys. A lot of debris accumulates in valleys. The seedlings of *Memecylon edule*, and *Musa superba* (*M. ensete*) grow in the ledges of rocks and on slopes. On the top of the hill, there is very little lateritic soil. Due to heavy rains much of it is washed down into the valleys. The vegetation on the top is of the monsoon deciduous type but not so uniform.

Flora of Raigad is similar, but is rich, as there is a continuous stream of humidity moving from sea towards the interior. Its vegetation is also of mixed deciduous forest type, and it has some semi-evergreen species from North Kanara and Goa.

A little further below the Fitzgerald ghat going to Mahabaleshwar the Savitri river flows. In the midst of its bed near Mahad, there are two hot springs but nobody has worked on their flora.

Greater Bombay :

The third important district is Greater Bombay with Salsette island. It extends from the Island of Bombay to Krishnagiri National Park at Borivali and the forest of Borivali. The flora of Greater Bombay has not been worked out. We know partly the flora of Krishnagiri National Park through the work of Santapau and Randeria (1955) and from the work of Dr. G. L. Shah (1970) who has studied the plants of Madh and Salsette islands. Here the sea makes incursion at many places and we find rich mangrove vegetation at a number of places like Bandra, Ghodbunder and Bhayander creeks. The forest in the valley of Borivali hills contains several monsoon deciduous species and also the Krishnagiri

National Park, similar to those in the valleys of Western Maharashtra, studied by Bole and his associates. They dry up early due to less humidity and no rains for about 8 months. During rains there is a rich monsoon ephemeral flora described by Santapau (1960), Mahabale (1966) and others.

Ratnagiri and Sindhudurg Districts :

The flora here has the same features as of Bombay and Thane. Some of the plants are described by Nairne (1894) and earlier by Dalzell (1850-52), Dalzell and Gibson (1861). The northern part of Ratnagiri is less humid than southern part separated by the creek of Malwan, Vengurla. Flora is similar to the flora of Greater Bombay, but that in South Konkan below Kumbharli Ghat upto Phonda, below Ramghat and Amboli is different. Here the soil is largely sandy and loamy. The rain lasts longer. There is great abundance of trees which look green throughout the year. But for the humidity throughout the year, they would have become completely deciduous. Many essential oil yielding grasses *e. g.*, *Cymbopogon nardus*, members of Compositae, Verbenaceae and Labiatae grow well. A large number of medicinal plants also grow well in Sawantwadi area. It is very suitable for the growth of fruit trees and palms, Cashewnut introduced by Portuguese, and nutmeg (*Myristica fragrans*) grow very well. *Theobroma cocoa* was introduced by Dalgado in Sawantwadi area and is growing well. Mango, black Pepper (*P. nigrum*) *p. longum*, *Mentha viridis*, *Mentha piperita*, *Hydrocotyle asiatica*, do well. *Eucalyptus* spp. are introduced in North and South Ratnagiri. The plants of Ratnagiri are a mixture of Konkan, Karnataka (North Kanara), Malabar and Goa plants. In the north Konkan palms, coconut and betelnut thrive well around Kudal, Shriwardhan, Roha, Alibag. At Kanakavali, thera is a good forest of monsoon deciduous species and it extends also to Phonda and Amboli ghats. Ghats all along Sahyadris are a unique conservatory of forest trees. Different plants grow at different heights as they need different variable climate.

Ratnagiri itself has equally good flora similar to that in other districts of Konkan. All the districts of Konkan seem to possess somewhat similar flora. At Ratnagiri, there is good forest of mangrove and strand plants.

6. Flora of Greater Bombay

A comprehensive flora of Greater Bombay district is yet to be prepared. We have therefore to rely on rather scanty information given by Dalzell and Gibson, Cooke and by various papers of Blatter, Santapau and his associates, and stray references to Bombay plants by various authors. The most important part of the flora of Bombay lies to the north of Bombay and in Salsette Islands where it is much destroyed. The sea shore flora is the same except that the proportion of different mangroves changes according to locality. After Independence, a special park called Krishnagiri National Park, Borivali has been created. It has effectively preserved certain species which otherwise would have disappeared. The full flora of this Park has not been published. Account of plants and vegetation in its certain parts has been given in a paper by Santapau and Randaria. "The botanical expedition of the Krishnagiri National Park, Borivli near Bombay" published in J. B. N. H. S. Vol. 53 (i) pp. 184-200, 1955. The river Dahisar passes through the middle of it. This part is rather barren but the valley to the north is full of plants typical of Bombay Island. Kanheri point is the highest peak 465 metres (1516′)

above the sea level. The hills as usual are the Deccan trap hills with wide plateaus on the top at many places. They are derived from volcanic rocks some of which are braccicated, especially in the region of Kanheri caves. Here both the acid and basic lava flow are found. The average rainfall is 190 cm. Much of it falls in the months of June and July. Driest months are December to April. About 95 per cent rain comes in the rainy season, and only 5 per cent during the rest of the year. Generally the highest temperature is in May and the lowest in January. Winds are mostly from north to north-east, but during the monsoons till about August they are from south-west to north-east. The vegetation is of the Southern Tropical moist deciduous type, but at many places it borders on the dry deciduous type, particularly on the eastern face. Dahisar river banks contain woody species such as *Holarrhena antidysenterica*, *Mangifera indica*, *Woodfordia fruticosa*, *Syzygium cumini*, *Homonia riparia*, *Pongamia pinnata* and such small trees. Behind these there are many climbers like *Derris scandens*, *Combratum ovalifolium*, *Argyreia nervosa*, *Smilax zeylanica*, *Jasminum malabaricum*. In drier parts *Argemone mexicana*, *Coldenia procumbens* grow in abundance.

In the bed of the river a number of water plants *Limnophila sessiliflora Nymphaea pubescens*, *Limnanthenum cristatum* occur. In the semi-dry places near the river *Coldenia procumbens*, *Sphaeranthus indicus*, *Grangea maderaspatana*, *Polygonum plebejum*, *Dopatrium junceum*, *Hydrolea zeylanica*, *Lindernia* sps. occur.

Vegetation along the main road, especially in the dry months allows only xerophytes like *Euphorbia hirta*, *Alysicarpus* sp. and the *Desmodium* species to survive. Species like *Gomphrena globosa*, *Acanthospermum hispidum* and such others are naturalised here.

The vegetation of the north and south hills along the main road is clearly a secondary formation ; the original forest has alomst completely disappeared from the whole of the park area. The hills are 83′ in height The forest may be said to be of the monsoon deciduous type. On the top *Terminalia crenulata*, *Tectona grandis*, *Garuga pinnata*, *Bridelia squamosa*, *Butea monosperma*, *Bauhinia racemosa*, *Ficus gibbosa*, *Mallotus philippinensis* are found. A few trees of *Adina cordifolia Oroxylum indicum*, *Kirganelia reticulata* occur and form open canopy. The seedlings of *Wrightia tinctoria*, *Holarrhena antidysenterica*, *Morinda tinctoria*, *Adenanthera pavoniana*, *Carvia callosa*, *Solanum indicum*, *Anisomelea hayneana* are found on the hill slopes and at the margin of the forest *Clausena indica* is found in the valley slopes of the upper layers. The ground layer is made up of *Hemigraphis latebrosa* var. *hyaneana*, *Haplanthus tentaculatus* var. *neesiana*, *Orthosiphon glabratus*. Some climbers grow also on top of hills. In addition to these *Dalbergia* sp. *Aspidopteris cordati*, *Cansjera rheedii*, *Pueraria tuberosa*, *Cissus* and *Ampelocissus* species are found throughout the forest. *Bambusa bambos* forms clumps Most of the southern area is deciduous But the humidity being high these forests do not look all dry as they do elsewhere. Above the Kanheri caves *Sterculia urens*, *Salmalia insignis*, *Tectona grandis*, *Lannea grandis*, *Carvia callosa*, *Barleria lawii*, *Haplanthes verticillaris* *Hymenodictyon comorense* are found.

There are several natural and artificial tanks or pools on the top of the hills. There is hardly any soil on the top. Here one notices *Tremma orientalis*, *Erythrina variegata* var. *orientalis*, *Adina cordifolia*, *Irewia polycarpa*, *Lantana camara* grow in drier parts every where and also *Dioscorea hispida*, *Smilax zeylanica*. But a characteristic feature of these hills are the monsoon plants listed below :—

Melothria maderaspatana.
Melothria heterophylla.
Cucumis callosus.
Trichosanthes bracteata.
Momordica dioica.
Luffa acutangula L. var. *amara.*
Neuracanthes sphaerostachyus.
Thumbergia fragrans.
Asystasia dalzelliana.
Sopubia delphinifolia.
Striga asiatica.
Eranthemum purpurascens.
Asteracantha longifolia.
Barleria pratensis.
Haplanthus pentagulatus var. *neesiana.*
Haplanthus verticillatus.
Rungia pectinata.
Rostellaria procumbens.
Costus speciosus.
Rhamphicarpa longiflora.
Murdannia scapiflorum.
Lindernia sps.

On the top of Kanheri caves *Dipcadi saxorum*, *Eulophia ochreatanum*, *Utricularia striatula*, *Segonia crenata*, *Ophioglossum fibronim*, *Eriocaulon*, sp. grow. Several grasses are there, but practically no trees on the top of caves. The origin of Krishnagiri National Park plants is as follows :—

6·1 Origin of the Plants in the Krishnagiri National Park

	Number	Percentage
Plants of		
Bombay State (old)	4	2.13
Bombay and South India	15	8.55
Bombay and other parts of India	48	25.66
West Asia and North Africa	19	10.16
East Asia and Malaya	47	25.13
Tropics	54	28.87

The presence of East Asian, Malayan and Tropical climbers is noteworthy. The family-wise distribution known is as follows :

FAMILIES OF GAMOPETALOUS ANGIOSPERMS OF KRISHNAGIRI NATIONAL PARK, BORIVALI

Order	Family	No. of spp. in Kr. Nat. park	Hooker's orders	Fisher's orders
(1)	(2)	(3)	(4)	(5)
1	Compositae	36	7	7
2	Acanthaceae	27	6	4
3	Convolvulaceae	22	..	..
4	Rubiaceae	20	4	3
5	Scrophulariaceae	13	..	..
6	Solanaceae	9	..	..
7	Labiatae	8	9	9
8	Verbenaceae	6	..	..
9	Asclepiadaceae	6	..	..
10	Apocynaceae	6	..	..
11	Bignoniaceae	6	..	..

Next we shall consider plants in other parts of Bombay. They are listed below :—

6·2 *Important Plants of Bombay Island* :

Species	Locality
Anonaceae	
Polyalthia longifolia	Jijamata Udyan (Victoria Garden) Byculla, Thane, Borivali.
P. pendula	Do.
Peltophorum ferrmigiosum ..	Do.
Cruciferae	
Brassica actinophylla	Do.
Capparidaceae	
Crataeva religiosa	Do.
Bixaceae	
Bixa orellana	Do.
Cochlospermum gossypium ..	Do.
Bombacaceae	
Ceiba pentandra	Do.
Sterculiaceae	
Guazuma tomentosa	Do.
Helicteris macrophylla:	Do.
Kleinhovia hispida	King's Circle, Borivali.

Species	Locality
Sterculia alata	Jijamata Udyan (J. U.) Byculla.
S. villosa	Do.
Sterculia colorata	Do.
S. foetida:	Do.
Rutaceae	
Aegle marmelos	Do.
Atlantia monophylla	Do.
Feronia elephantum	Do.
Filicium decipiens	Do.
Meliaceae	
Azadirachta indica	J. U. Byculla, Borivali, Thane.
Melia azadirach	Do.
Swietenia mohogonii	Do.
Swietenia macrophylla	Do.
Sapindaceae	
Schleichera cleosa	Do.
Anacardiaceae	
Anacardium occidentale	Do.
Semicarpus anacardium	Do.
Leguminosae	
Papilionaceae	
Butea monosperma	Do.
Dalbergia sisoo.	
Sesbania grandiflora.	
Clitoria ternata	Do.
Pongamia glabra	J. U., Thane, Borivali.
Caesalpinaceae	
Saraca indica	J. U., Byculla.
Amherstia nobili	Do.
Bauhinia racemosa	Do.
B. purpurea	Do.
Caesalpinia cariaria	Do.
Cassia fistula	Do.
C. nodosa	Do.
C. renigera	Do.
C. siamea	Do.
Plumeria rubra	Do.
Thevetea peruviana	Do.
Convolvulaceae	
Ipomoea biloba	Juhu.
I. aquatica	J. U. Byculla.
I. palmata	Thane.
I. quamoclit	Thane.
Acanthaceae	
Peristrophe bicalyculata	Borivali, Thane.

Species	Locality
Euphorbiaceae	
Mallotus phillipinensis	J. U. Byculla.
Melaleuca leucodendron	Do.
Phyllanthus disticha	Do.
Putranjiva roxburghii	Do.
Urticaeae	
Artocarpus integrifolia	Do.
A. mobilis	Do.
Collevillia racemosa	Do.
Trema orientalis	Do.
Streblus asper	Do.
Mimosae	
Acacia catechu	Do.
A. auricuiformis	J. U. Borivali.
A. arabica	Do.
Adenanthera pavonina	Do.
Albizzia lebbek	J. U., Parel.
Rhizophoraceae	
Avicennia sp. (alba. ? officinalis ?)	Thane.
Rhizophora mucronata	Thane.
Combretaceae	
Terminalia arjuna	J. U. Byculla.
T. bellerica	Do.
T. catappa	Do.
Bignoniaceae	
Bignonia megapotamica	Do.
Cresentia alata	Do.
C. cujete	Do.
Sapotaceae	
Chrysophyllum tuberosum.	
Apocynaceae	
Plumeria alba	Do.
Monocotyledons	Do.
Araceae	
Pistia stratoitis	Do.
Orchidaceae	
Acampe sps.	Do.
Musaceae	
Musa sp.	
Ravanela madagascarensis ..	Do.
Liliaceae	
Chlorophytum tuberosum	Borivali.

Species	Locality
Palmae	
Roystonea regia	J. U. Byculla.
Rhapis humilis:	Do.
Livistona chinensis	Do.
L. rotundifolia:	Do.
Licuala spinosa	Do.
L. grandis	Do.
Borassus flabeilfer	Sea shore.
Phoenix sylvestris.	
Pandanaceae	
Pandanus odoratissimus	Ghodbunder, Borivali,
Lemnaceae	
Lemna minor	J. U. Byculla.

6.3. *Flora of Salsette and Madh Islands*

Madh and Salsette are the component parts of Greater Bombay district. They are two separate islands and have very distinct flora. It has been worked out by Dr. G. L. Shah who has published plants found on them including weeds and grasses found. However his entire work is yet to be published and therefore, lists of plants he has recorded are reviewed here. They offer a fair glimpse of the flora of these places, but not the entire picture of it. The Madh island belongs to the Bombay sub-group of islands and Salsette. Much of its flora has gone buried under the debris. Only a small portion of it still remains near the Bandra bridge near Bandra Station on Eastern Highway going to Santacruz Air-port. Here patches of mangroves are still visible, though much of it is destroyed at Mahim.

Enumeration of Important plants of Salsette and Madh Islands of Bombay

Family Ranunculaceae
Clematis hedysarifolia DC.

Anonaceae
Anona squamosa Linn.

Manispermaceae
Cissampeles pareira Linn.
Cocculus hirsutus (Linn.) Diels
Cyclea burmanni DC
Tinospora cordifolia (Willd.)
Miers ex Hook and Thoms.

Nymphaeaceae
Nymphaea nouchali Burm.
N. stellata Willd.

Papavaraceae
Argemone mexicana Linn.
anexotic weel.

Cruciferae

Brassica nigra (Linn.) Koch.
Raphanus sativus Linn.

Capparidaceae

Cadaba fruticosa (Linn.) Druce.
Capparis sepiaria Linn.
C. zeylanica Linn.
Cleome burmanni W. and A.
Cleome chelidonii Linn. f.
Gynandropsis gynandra Linn.
G. viscosa Linn.

Violaceae

Hybanthus anneaspermus (Linn.) F. Muell.

Flacourtiaceae

Flacourtia indica (*Burm.* f.) Muell.

Polygalaceae

Polygala chinensis Linn.

Caryophyllaceae

Polycarpon prostratum (Forst.) Aschers & Schewinf.

Portulacaceae

Portulaca oleracea Linn.

Elatinaceae

Bergia emmannioides Heyne ex Koth.
B. capensis Linn.

Guttiferae

Calophyllum inophyllum Linn.
Mammea suriqa (Buch-Ham ex Roxb.) Kosterm.

Malvaceae:

Abelmoschus esculantus (Linn.) Mosuch.
A. manihot (Linn.) Medic.
Abutilon indicum (Linn.) Sw.
Azanza lampas (Cav) Alel.
Hibiscus cannabinus Linn.
H. furcatus Willd.
H. lobatus (Murr.) O. Kuntze.
H. vitifolius Linn.
Malachra capitata Linn.
Sida acuta Burm. f.
S. cordifolia Linn.
S. shembifolia L. var. *ratusa* (Linn.) Masters.
S. apinosa Linn.
S. varonicifolia Lamk.

Thespasia populnea (Linn.) Soland ex Corr.
Urena lobata Linn.
Bombax ceiba Linn.

Sterculeaceae
Helicteres isora Linn.
Melochia corchorifolia Linn.
Sterculia foetida Linn.
S. villosa Roxb. ex DC.
S. ureus Roxb.
Waltheria indica Linn.

Tiliaceae
Corchorus asituans Linn.
C. olitorius Linn.
Grewia abutifolia Vent ex Jurs.
G. columnaris Sm.
G. disperma Rottel. ex. Spreng.
G. subinaequalis DC.
G. tiliaefolia Vahl.
Microcos paniculata Linn.
Triumfetta pentandra A. Rich.

Balsaminaccae
Impatiens balsamina Linn. var. *balsmina.*

Oxalidaceae
Biophytum sensitivum (Linn) DC.
Oxalis corniculata Linn.

Rutaceae
Aegle marmelos Corr.
Feronia limonia (Linn.) Sw.

Burseraceae
Garuga pinnata Roxb.

Meliaceae
Azadirachta indica (Linn.) A. Jussu.

Opiliaceae
Canalara sheeldii Gmel.

Celastraceae
Celastrus paniculata Willd.

Rhamnaceae
Zizyphus glabrata Heyne ex Roth.
Z. mauritiana Lamk.
Z. oenoplia Muell.
Z. rugosa Lamk.

Vitaceae
Ampelocissus latifolia (Roxb.) Planch.
Caryratia rapanda Vahl.
Leea cinera Laws.
L. edgeworthii Santapau.
L. macrophylla Roxb. ex Hornem.

Sapindaceae
Sapindus laurifolius Vahl.
Cardiospernium halicacabum Linn.

Anacardiaceae
Anacardium occidentale Linn.
Buchanania lanzan Spreng.
Lannea coromandelica (Houpt) Merill.
Mangifera indica Linn.
Semecarpus anacardium Linn.

Cooke (1905) in his *Flora of the Bombay Presidency* has described 337 species as occurring in Konkan including Sawantwadi. They include many floristically important plants that occur in Belgaum, Dharwar, North Kanara and Sawantwadi. Botanically these are rich districts but are a part of Karnatak State except Sawantwadi in Maharashtra. But they were given without localities or in general vague terms such as Konkan country, etc. The list therefore is not given and the plants of only five districts of Thane, Kolaba (Raigad), Greater Bombay, Ratnagiri and Sindhudurg are considered here.

Plants of Salsette and Madh Islands—Monocoty ledons

Species	Flowering season
Hydrocharitaceae :	
Blyxa echinosperma (Clke.) Hook F. ..	November-December
Hydrilla verticillata (Linn. F) Royle ..	November-December
Ottelia alismoides (Linn.) Pers.	October—December
Orchidaceae :	
Acampe pramorsa (Roxb.) Blatt and M. C.	March—June
Dendrobium ovatum (Willd.) Kranz.	December-January
Habenaria marginata Coleb.	August-September
Rhynchostylis retusa (L.) Blume	January—July
Zingiberaceae :	
Costus speciosus (Koening ex Ratz) ..	July—September
Curcuma inodora Blatt.	June—August
Hypoxidaceae :	
Curculigo orchioides Gaertn.	June—August
Taccaceae :	
Tacca leontopataloides (L) D. Kuntze ..	July—September
Dioscoraceae :	
Dioscorea alata Linn.	
Dioscorea belophylla Voigt.	
Dioscorea bulbifera Linn.	August-September
Dioscorea pentaphylla	August—October
Dioscorea wallichii Hook. f.	November
Liliaceae :	
Asperagus racemosus Willd. var *Javanicus* Baker.	
Chlorophytum tuberosum Baker	June—August
Gloriosa superba Linn.	August-September

Iphigenia indica (Linn.) A. Gray.	July
Scilla hyacinthina (Roth) Macbr.	June-July
Urginea indica Kunth.	March-April
Smilacaceae :	
Smilax zeylanica Linn.	September-October
Commelinaceae :	
Commelina banghalensis Linn.	July—October
Commelinea hasskarlii Clke.	July—November
Commelina diffusa Burm.	August—September
Commelina subfruticosa Blume.	July—October
Cyanotis axillaris (Linn.) Schult. f.	August—January
Cyanotis cristata (Linn.) Schult. f.	July—October
Cyanotis fasciculata Schult. f.	July—November
Murdannia semiteres (Dalz.) Sand.	July-August
Murdannia spiratum (Linn) Srueck.	September
Palmae :	
Borassus flabellifer Linn.	February—April
Caryota urens Linn.	
Cocos nucifera Linn.	
Phoenix sylvestris (Linn.) Roxb.	January—March
Pandanaceae :	
Pandanus odoratissima Linn. f.	
Typhaceae :	
Typha angustata Bory and Chaub.	November—February
Araceae :	
Amorphophallus campanulatus (Roxb.) Blume. ex Decais.	June
Amorphophallus commutatus (Schott.) Engl.	March—July
Colocasia antiquorum Schott.	August-September
Alismaceae :	
Limnophyton obtusifolium Mig.	December—March
Aponogetonaceae :	
Aponogeton netans (Linn) Engl. Krause	July
Eriocaulaceae :	
Eriocaulon dianae Fyson D. var *longibracteatum* Fyson.	November—March
Eriocaulon cleonaras Fyson	September
Cyperaceae :	
Cyperus albomarginatus Mart. and Schrad.	September-October
Cyperus bulbosus Vahl.	July—September
Cyperus compactus Retz.	September—November
Cyperus compressus Linn.	July—September
Cyperus difformis Linn.	All the year
Cyperus escaltatus Retz.	September-October
Cyperus iria Linn.	Entire year

Cyperus kyllingia Endl.	July—September
Cyperus leucocephalus Retz.	July—September
Cyperus malabaricus (Clke.) Coske	August—October
Cyperus metzii (Hochst.) Matt. and Kukenth	August
Cyperus michelianus (Linn) Link.	December-January
Cyperus pygmaeus (Rottb.) Aschers Gasbn.	
Cyperus nutans var *Eleusinoides* ((Kunth) Hainas.	June—December
Cyperus pangorii Roxb.	
Cyperus pumilus Linn.	August—October
Cyperus rotundus Linn.	July—September
Cyperus squarrosus Linn.	July—September
Cyperus tenuiflorus Roxb.	September-December
Cyperus triceps Endl.	August
Eleocharis atropurea Kunth	August—December
Eleocharis spiralis Roxb. R. Br.	August
Fimbristylis aestivalis Vahl.	December
Fimbristylis bisubumbellata (Fonks) Bud.	September—March
Fimbristylis cymosa R. Br.	July—January
Fimbristylis dichotoma (L.) Vahl.	July—December
Fimbristylis falcata (Vahl.) Kunth	June-July
Fimbristylis ferruginea vahl	October
Fimbristylis littoralis Gandich.	September—November
Fimbristylis miliacea (L.) Vahl.	October-November
Fimbristylis polythricioides Vahl.	September-October
Fimbristylis schoenoides Vahl	August—October
Fimbristylis tenera Roem and Schult.	July—October
Fimbristylis tetragona R. B.	August—September
Fuirena ciliaris (Linn.) Roxb.	November—March
Rhynchospora wightiana (Nees) Steud.	August-September
Scirpus articulatus Linn	October-November
Scirpus grossus Linn.	October-November
Scirpus lateriflorus	November-December
Scirpus littoralis Schrad var. *subulatus* chiov.	October
Scirpus maritimus Linn.	July—September
Scleria tessellata Willd. var· *flora* (Roxb.) Blatt. and Mc.	August—November

Gramineae :

Aleuropus lagopoides (Linn) Trin. ex Thw.	October-November
Alloteropsis climicina (Linn) stapf	July-August
Apluda mutica Linn.	September—December
Arthraxon lanceolatus (Trin.) Hochst.	September-October
Arundiella metzii Hochost.	October-November
Bothriochloa pertusa (Linn.) A. Camus	August-September
Brachiaria ramosa (Linn.) Stopf.	July-August
Capillipedium filliculme (Hook. f.) stapf.	November
Capillipedium huqueii (Hook.) Camus.	October
Chionachna koenigii (Spreng. Thu)	October
Chloris barbata Sw.	August—October
Chloris montana Roxb.	July
Chloris quinquestetica Bhide	September
Chloris virgata Sw.	August—September
Coix lachryma-jobi Linn.	September-October
Cynodon dactylon (Linn.) Pers.	August—September
Dactyloctenium aegyptiacum (Linn.) Willd.	July—October
Dactyoctenium sindicum Boiss.	August—November

Desmostachya bipinnata (Linn) Stapf. ..	November
Digttaria adscendena (H. B. K.) Henr. ..	November
Digitaria alscendens (H. B. K.) Henr. ..	
var. *chrysoblephera* Henr.	September
Digitaria adscendens H. B. K.	
var. *marginata* Link.	October
var. *criniformis* Henr.	
Digitaria oranularis (Trin) Henr.	July-August
Digitaria logiflora (Retz) Pers.	July
Digitaria stricta Roth. ex. R. C. S. ..	September
var. *stricta*.	
Digitaria timorensis Kunth	November
Dimeria stapfina Hubb. ex. Piger	October
Dinlachna fusca (Linn.) Beauv.	June—February
Echinochlea colonum (Linn.) Link.. ..	July—October
Echinochlea crus-galli (L.) Geauv.	October-November
Eleusine indica L. Gaertn.	August—January
Elytrphorous spicatus (Willd.) Acamus. ..	November
Eragrostis ciliaris (L.) R. Br.	September-October
Eragrostis chariis (Schult) Hitch.	September—November
Eragrostis pilosq (L.) Beauv.	July--October
Eragrostis temifolia (Zucc.) Trott.	September
Eragrostis tenella (Linn) Beauv. ex. R and S	October
Eragroatis tremula (Lamk.) Hochst. ..	October
Eragrostis unioloides (Retz.) Nees ex Staud	July—October
Eriochloa procera Hubb.	July—September
Eulalia fimbriata (Hack.) Blatt and Mc ..	October
Heteropogon contortus (Linn.) Beauv. ..	September—January
Iscehne dispar Trin.	September—February
Isachne globosa (Thumb.) O. Kunze ..	August—October
Ischaemus indicum (Houst) Merrill ..	September
Ischaemum santapaui Bor	October
Iseilema laxum Hack.	September
Melanocenchris jacquemontii Jaub. ..	October
Ophiurus exaltatus (L.) P. Kuntze	May
Oplismenus burmanni (Retz) Beauv. ..	September—November
Oryza rugipogon Linn.	September-October
Penicum psilopodium Trin.	July-October
Penicum psilopodium Trin.	July—October
var *coloratum* Hk. f.	
Paspalidium flavidum (Retz) A. camus ..	July—October
Paspalidium arbicularie Forst	August
Paspalum scrobiculatum Linn.	July
Pannisetum typhoides (Burm. f.) Stapf. ..	September-October
Pseudanthistiria heteroclita (Roxb) Hk. F.	September—November
Pseudanthistiria spineseens (R. Br.) vickary	September
Saccharum spontaneum Linn.	November
Sacciolepis interrupta (Willd. Stapf.) ..	October—March
Setaria verticillata Beauv.	October
Setaria glauca (Linn.) Beauv. ..	July—September
Setaria pallida fusca (Schum.) Staff and Hubb.	July—September
Setaria tomentosa (Roxb.) Kunth. ..	August
Sporobolus capillaris Arniex Mig	August-September
Sporobolus marginatus Hoechst	July
Spinifex littoreus (Burm. f.) Merr. ..	December—February
Themeda quadrivalvis (Linn.) G. Kuntze	September—December
Themeda triandra Forsk.	September—November

Cultivated Grasses of Salsette Island

Name (1)	Fl. season (2)	Locality (3)
Digitaria adscendens H. E. K. Bernard.	Sept. ..	Madh islands along residences.
Digitaria timorensis (Kunth) Bel.	Nov.	Occasionally found on roadside.
var. *blepharophora* Henrard Mon.		
Isachne dispar Trin. sp. cr. am Icon.	..	Common along water ditches.
Oryza sativa L. (Notulae) ..	Sept-Oct.	
Paspalum orbiculare Forst ..	Aug. ..	Along margins of a pond on Madh island.
Setaria pallidifusca (*Schum*) ..	July-Sept. ..	Common in open grasslands on hills.

6·4 Grasses of Bombay, Madh and other Surrounding Places in Konkan.

1. *Spinifex Squarrosus* Linn.	Nov. ..	On the sandy shores of Konkan, Bandra.
2. *Pennisetum orientale* Rich	July ..	Konkan.
3. *Sataria plicata cooke* ..	Nov. ..	Western side of ghats.
4. *Setaria glauca* Beauyv. ..	Oct. ..	Konkan.
5. *Setaria intermedia* Roam: and Schult.	Aug-Sept., Oct.	Konkan in cultivated fields.
6. *Setaria verticillata* Beauv.	..	Konkan.
7. *Shamaarachis spiniscence* Poir.	Sept. ..	Vangni.
8. *Isachne elegans* Dalzell ..	Sept. ..	N. A.
9. *Isachne miliacea* Roth ..	..	Konkan, Lonavala.
10. *Axonopus cimicinus* Beauv.		
11. *Oplismenus compositus* Beauv.	Nov. ..	At the foot of ghats in Konkan.
12. *Opliamenus burmanni* Beauv.	Sept-Oct. ..	Konkan.

13. *Panicum flavidum* Ratz.	Oct.	North and south Konkan.
14. *Panicum stagninum* Ratz.	Oct.	Cultivated fields.
15. *Panicum colonum* Linn.	Oct.	
16. *Panicum interruptum* Willd.	Oct-Feb.	Panvel, Vengurla.
17. *Panicum myosuroides* R. Dr.	Oct. onwards	Sawantwadi, Alibag.
18. *Panicum trypheron* Schultz.	Sept.	Malabar Hill.
19. *P. proliferum* Lam. var. *paludosum* Stapl.	..	Salsette.
20. *P. montanum* Roxb.	Jan.	Khardi (Thane Dist.).
21. *P. maximum* Jacq.	..	Often cultivated as fodder grass, Konkan.
22. *P. muticum* Forsk.		
23. *Digitaria pedicellaris* Prain.	Konkan.	
24. *D. Royleana* Prain	Dec.	Western ghats
25. *Paspalum acrobiculatum:*	Oct.	Cultivated
26. *Paspalum compactum* Roth	Sept.	Konkan
27. *P. distichum* L.	Oct.	Sea shore Bombay, Malwan.
28. *Eriochloa polystachya:* H. B. and K.	Oct.	Bombay.
29. *Dimeria woodrowii* Stapf	Oct.	Ratnagiri
30. *Dimeria gracilis* Nees	Dec.	Konkan
31. *Imperata arundinaccia* Cyrill.	..	Konkan
32. *Spodiopogon albidus* Bantham.	Oct.	Konkan, Ghats, Matheran, Salsette.
33. *Saccharum spontaneum* Linn.	..	Karjat
34. *S. offisinarum* Linn.	..	Cultivated
35. *Palunia argentae* Trin.	Oct-Dec.	..
36. *Palunia fimbriata* Hock	Oct.	Konkan
37. *Rottboellia acuminata:* Hack.:	Oct.	Malwan
38. *Rottboellia exaltata* Linn.	Nov.	Konkan
39. *Apluda varia* Hack	Oct-Dec.	Konkan
40. *Ischaemum aristatum* Linn.	Oct-Dec.	Matunga
41. *I. diplopogon* H. K. f.	..	Matheran
42. *I. semisagittatum* Roxb. var. *dasiantha* Hack.	Sept-Nov.	Konkan
43. *I. cilliare* Retz.	Oct.	Salsette, Parel

44. *I. spathiflorum* Hook	Sept.	Salsette island
45. *Lophopogon tridentatus* Hack.	Oct.-Dec.	Konkan
46. *Apocopis vaginatus* Hack	..	Kalyan
47. *Arthraxon inermis* Hooker	Oct.	Matheran
48. *Arthraxon microphyllus* Hochst.	Sept.	Salsette, Parel
49. *Arthraxon jubatus* Hack.	Oct.	Konkan
50. *Thalepogon elegans* Roth	Sept.	Konkan
51. *Andropogon kuntzeanus* Hack.:	..	Mawal, Konkan
52. *Andropogon concanensis:* Hook.	Oct.	Matheran
53. *Andropogon odoratus* Da. Lish.:	Oct.	Khardi
54. *Andropogon halepensis* Brot.	Dec.	
55. *Andropogon armatus* Hook		
56. *Andropogon annulatus* Forsk.	Oct.	Konkan
57. *Andropogon triticeus* R. Br.	Dec.	Konkan
58. *A. sorghum* Brot	..	Cultivated
59. *A. squarrosus* Linn.	..	Cultivated as fodder
60. *A. schoenanthus* Linn.	..	Cultivated for its oil in Konkan.
61. *Themeda imberbes* T. Cooke.	..	Cultivated
62. *Themeda ciliata* Hack	Sept.-Jan.	South Konkan, Salsette.
63. *T. cymbaria* Hack.	..	Konkan common
64. *T. triandra* Hack.	Oct.	Common near Raita.
65. *Iseilema laxum* Hack	Nov.-Dec.	Doubtful
66. *Coix lachryma* Linn.		
67. *Polytoca cookei* Stapf.	Sept.	Bombay, Salsette.
68. *Arundinella arenacea* Mun	Oct.	Ratnagiri
69. *A. setosa* Trin.	..	Bombay
70. *A. tenella* Nees	Nov.	Bombay
71. *A. pygmaea* Hook	Sept.	On the crest of the western ghats.
72. *A. lawii* Hook.	..	Konkan
73. *A. capillaris* Hook.	..	Panvel
74. *A. gigantea* Dalz.	Oct.	N. A.
75. *Thysanolaena agrostis* Nees	Jan.	Thane
76. *Aristida setacea* Retz.	..	Salsette

77. *Garnotia stricta* Brongn		Neral near Karjat.
78. *Tragus racemosus* Scop.	Sept.	Salsette
79. *Parotis latifolia* Ait.		Malwan
80. *Sporobolus minutiflorus* Ling.	Oct.	Parel
81. *S. coromondellianus* Link	Jan.	Bombay
82. *Eragrostis aspera* Nees.		Konkan
83. *E. tenella* Woodr.	Nov.	Konkan
84. *E. interrupta* Beauv	Nov.	Vasai, Thane
85. *E. amabilis* Wight and Arn.	Sept.-Nov.	Parel, Vasai
86. *E. stenophylla* Hochst.		Malwan
87. *Diplachne fusca* Beauv.		Matunga
88. *Gracilea royleana* Hook.		Konkan
89. *Cynadon dactylon* Pers.		Grows throughout the State.
90. *Chloris incompleta* Roth.		Thane
91. *Tripogon pauperculus* Stapf.	Sept.	Western ghats
92. *T. capillatus* Jaub.	Sept.	Matheran on trace
93. *T. lisboae* Stapf.		Karla
94. *T. jacquemontii* Stapf.		Bombay, Matheran
95. *Eleusine aegyptiaca* Desf.	Sept.-Nov	Ratnagiri
96. *Eleusine aristata* Ehrenb.		Ratnagiri
97. *Eleusine coracana* Gertn.		Wildly cultivated in hilly parts.
98. *E. dinebra arabica* Jacq.	Aug.	
99. *Alytrophorus articulatus* Beauv	Nov.-Feb.	Kalyan
100. *Aleuropus villosus* Trin.	Nov.-Dec.	Salt marshes and ground near sea Salsette.
101. *Bambusa arundo* Willd.		In ghats
102. *Oxytenanthera monostigma* Bedd.		Konkan ghats
103. *O. stocksii* Munro	Nov.	
104. *Dendrocalamus strictus* Nees.		Planted in deciduous forest.

6·5 *Weeds of Bombay and Neighbourhood*

These have been studied by G. L. Shah (1964-65). The list given by him is also applicable to many rice fields in other places in Maharashtra, especially where rainfall is heavy or moist soils, drying gradually, but not dry soils on waste lands.

A weed is defined as an unwanted plant in a place, or a plant in wrong place. Some of them are indigenous and many are exotic having come from other lands with men, birds and other animals. *Parthenium histerophorus* is an example of a weed that has come from South America with food consignments. Seeds of *Datura stramonium* are found in the wheat that comes from Australia. During the World War I, *Amarantus bispinosus* has come to India from Mesopotemia with the luggage of soldiers that had gone to Iraq and Middle East. Similarly *Acanthospermum hispidum, Xanthium stumairum* and other exotic weeds have come to India. All weeds are harmful to man, crops, cattle etc., e. g. *Parthenium histerophorus* causes allergy in some persons. Some of them are capable of even killing cattle. Some harbour fungi and other organisms which cause diseases in cows, sheep and horses e. g. Ergot on Rye and other grasses. Grasses e. g. *Andropogon odoratus*, *Anthistatia ciliata* harbour rice stem-borer insect *Schenobius punctifer*. It is believed that dry regions of the world possess maximum number of weeds.

Adulteration of food due to weed seeds is quite common. For example, the seeds of Mexican weed *Argemone maxicana* are often mixed with mustard seeds. It contains a lot of oil which causes symptoms similar to allergy when mixed with edible oils. Many more examples of this kind could be found in any flora. However some of them are potential drugs. A weed which is unwanted in one place may be useful in another place for a biological succession and control. Weeds multiply and spread rapidly producing new races especially those that belong to Compositae. There are two distinctive groups of them: In the first group are the weeds of aquatic plants. Rice is a marshy crop plant. As the water dries and the fields become open, hydrophytic weeds growing in the water logged fields begin to flower from August to September. In the second group the flowering of weeds starts from December and lasts till April (See lists below). Some of the weeds are quite drought resistant. Some of them grow even in salty soils marshes and mud e.g. *Cressa cretica,* species of *Ammania* and others

List of such common weeds found in Bombay flora is given below :—

Capparidacae
Cleome viscosa Linn.

Violaceae
Hybanthus anneaspermus (L) F. Muel.

Portulacaceae
Portulaca oleracea Linn.

Malvaceae
Abutilon indicum (L) Sw.
Sida rhombifolia Var. *retusa* Masters.

Linaceae
Linum usitatissimum L.

Papilionaccae
Alysicarpus longifolius W. and A.
Alysicarpus hamoaus Edgew.
Alysicarpus vaginalis (L) DC.
Crotolaria linifolia L. f.
Mallotus indica Al.
Vigna capensis Walp.

Caesalpiniaceae
Cassia tora L.

Molluginaceae
Mollugo pentaphylla L.

Rubiaceae
Anotis foetida Ben and HK.
Oldenlandia corymbosa L.

Compositae
Ageratum conyzoides L.
Eclipta prostrata L.
Eclipta alba (L) Hassk.

Solanaceae
Datura fastuosa L.
Datura fastuosa L. f. var. *alba* (Nees.) Clarke.
Physalis minima L. f.
Solanum nigrum L.
Solanum surattanse Burm. f.

Pedaliaceae
Sesamum indicum L.

Acanthaceae
Asteracantha longifolia (L.) Nees.
Haplanthus neilghirensis Wt.
Peristrophe bicalyculata (Retz) Nees.

Verbenaceae
Phyla nodiflora (L) Green.
(*Lippia nodiflora* A. Mich).

Amaranthaceae
Amaranthus spinosus L.
Celosia argentea L.
Digera muricata (L) Mart.

Euphorbiaceae
Acalypha ciliata Forsk.
Acalypha indica L.
Euphorbia hirta L.
Kirganelia reticulata (Poir.) Baill.
Phyllanthus fraternus Webster.
Phyllanthus niruri Sanau Hk. f. non-Linn.

Commelinaceae
Commelina diffusa Burm. f.
Commelina hasskarlii Clarke.
Commelina paludosa Bl.
Commelina obliqua Buch-Ham. ex Don. non Vohl.
Commelina suffruticosa Bl.
Cyanotis cristata Schult. f.
Aneiloma nudiflorum R. Br.

Papilionaceae
Lathyrus sativus L.
Pisum sativum L.

Mimosaceae
Mimosa pudica L.

Cucurbitaceae
Citrullus lanatus Thumb.

Convolvulaceae
Ipomoea hederacea Jacq.
Ipomoea carica (L) Sw.

Acanthaceae
Justicia gendarussa Burm. f.

Papaveraceae
Argemone mexicana Linn.

Passifloraceae
Passiflora foetida Linn.

Compositae
Acanthospermum hispidum DC.

Campanulaceae
Laurentia longiflora (L) Petermann.

Lobeliaceae
Lobelia chinensis Lour.

Convolvulaceae
Evolvulus nummularius (L). Linn.
Impomoea triloba Linn.

Solanaceae
Physalis longifolia Nutt.

Scrophulariaceae
Scoparia dulcis Linn.

Verbanaceae
Lantana camara L. var. *aculata* (L) Moid.

Amaranthaceae
Alternanthera ficoides (L) R. Br.
Alternanthera pungens H. B. K.
Gomphrena celosioides Mart.
G. globosa Linn.

Phytolaccaceae
Rivina humilis Linn.

Piperaceae
Peperomia pellucida H. B. K.

Urticeceae
Pilea microphylla (L.) Liebm.

Pontederiaceae
Eichhornia crassipes Solsm.

6.6. *Weeds in cultivated fields and drying ponds* :—

During rainy season rice is cultivated on a large scale in various parts. Rice seeds contain seeds of *Ammania multiflora*, Roxb., *Jussiea suffruticosa* L. and *Isachne globosa* O. K.

In ponds and ditches *Nymphaea nouchali* Burm. f. *N. stellata* Willd. *Nymphoides cristatum* o. k. *N. indicum* etc., are common, but *Trapa bispinosa* is rare.

If the ponds are deep *Ottelia alismoides* grows after the monsoons. Ditches being temporary, they dry up from November and a new set of weeds begins to appear. They are :

Heliotropium ovalifolium Forsk.
Sphaeranthus indicus Linn.
Crangea maderaspatana Poir,
Bergia ammannioides Roxb.
Coldenia procumbens Linn.
Dentella repens Forst.
Euphorbia thymifolia Linn.
Glinus potoudes Linn.
Hydrolea zeylanica Vahl.
Hygrophila serpillum T. Anderes.
Lobelia alsinoides Lamk.

Oxalidaceae :
Biophytum sensitivum (L.) DC.
Oxalis corniculata Linn.

Papilionaceae :
Aeschynomene indica Linn.
Sasbania bispinosq (Jacq) F. and R.
Smithia salsuginea Hance.
Smithia sensitiva Ait.
Zornia diphylla (L) Pers.

Lythraceae :
Ammannia baccifera Linn.
Ammania multiflora Roxb.
Rotala indica (Willd) Koehne.

Onagraceae :
Ludwigia parviflora Roxb.
Jussiaea suffruticosa Linn.

Molluginaceae :
Mollugo hirta Thunb.

Rubiaceae
Dentella repens Forst.
Oldenlandia corymbosa Linn.

Compositae :
Caesulia axillaris Roxb.
Emilia sonchifolia (L) DC.

Epaltas divaricata Cass.
Gnaphalium indicum Linn.
Grangea maderaspatana (L.) Poir.
Sphaeranthus indicus Linn.

Lobeliaceae :
Lobelia trigona Roxb.

Gentianaceae :
Conscora diffusa (Vahl) R. Br.

Hydrophyllaceae :
Hydrolea zeylanica (L) Vahl.

Boraginaceae :
Coldenia procumbens Linn.
Heliotropium ovalifolium Forsk.

Convoluvulaceae :
Cressa cretica Linn.

Scrophulariaceae :
Donatrium junceum (Roxb.) Buch-Ham.
Lindernia ciliata (Colsm) Pennell.
Paplidium maritimum (L. F.) Watta.

Lentibulariaceae :
Utricularia reticulata Sm.

Acanthaceae :
Asteracantha longifolia (L.) Nees.
Hygrophila polysperma (Roxb.) T. Anders.
Hygrophila serpyllum (Nees) T. Anders.
Rungia repens (L) Nees.

Amaranthaceae :
Alternanthera sessilis (L.) DC.

Chenopodiaceae :
Chenopodium album Linn.

Polygonaceae :
Polygonum plebejum R. Br.

Eriocaulaceae :
Eriocaulon dianae Fyson.
Eriocaulon eleanoras Fyson.

Cyperaceae :
Cyperus difformis Linn.
Fimbristylis diphylla (Retz) Vahl.
Fuirena ciliaris Roxb.
Scirpus supinus Linn.

Gramineae :
Eragrostis tenella P. Beauv.
Isachne globosa (Thunb) O. K.

6·7. Weeds along the sea side ponds and sandy shores.

They mostly have *Sesuvium portulacastrum*, *Sueda fruticosa*, *Pentatropis spiralis*, *Blumea obliqua*, *Malachra capitata*, *Sphaeranthus africanus*, *Cyperus bulbosus*, *Hibiscus lobatus*. Others are:—

Family Compositae :
Sphaeranthus africans Linn.

Family Boraginaceae :
Heliotropium marifolium Retz.
Trichodesma amplexicaule Roth.

Family Convolulaceae :
Ipomoea pes-caprae Sw.

Family Gramineae :
Spinifex littoresus (Bl.) Merrill.

6·8. List of Halophytes of Bombay and Salsette Islands :

Halophytes of Bombay and Salsette Islands are conspicuous in certain areas. They are :—

1. *Acanthus ilicifolius* Linn.
2. *A. ebracteatus* Vahl.
3. *A. volubilis* Wall.
4. *Acrostichum aureum* Linn.
5. *Aegiceras majus* Gnartn.
6. *Arthochnemum indicum* Mog.
7. *Atriplex stocksii* Boiss.
8. *Avicenia alba* Blume.
9. *A. oficinalis* Linn.
10. *A. nitida* See and Mac
11. *Bruguiera gymnorhiza* Lam.
12. *Ceriops candolleana* Arn.
13. *Clerodendron inerme* Gaertn.
14. *Cressa cretica* Linn.
15. *Eugenia corymbosa* Borg.
16. *Excoecaria agallocha* Linn.
17. *Kandelia Rheedii* W and A.
18. *Kochia indica* Wight.
19. *Lumnitzera coccinea* W and A.
20. *L. racemosa* Willd.
21. *Rhizophora mucronata* Lam.
22. *Salicornia brachiata* Roxb.
23. *Salsola foetida* Deule.
24. *S. kali* Linn.
25. *Salvadora persica* Linn.
26. *Sesuvium portulacas trum* Linn.
27. *Sonneratia acida* Linn.

6·9. *Gharapuri or Elephanta Island and its Plants* :

Near Bombay Island there are quite a few islands, more important of which are Salsette, Madh and Gharapuri or Elephanta. Elephanta cave is also famous for the Maheshmurti embodying Lord Shiva the Creater, Protector and Destroyer. It can be approached by launch being a few miles to the South East of Bombay proper. It is surrounded by mangroves and has plants not different from those on Bombay Island. Obviously it must have been a part of it and got separated in the past.

The subjoined list will show that they are the same as on main land of Bombay.

Vegetation of Elephanta Island or Gharapuri near Bombay.

(A list of plants)

Anonaceae:
Anona squamosa

Capparidaceae:
Crataeva sp.
Capparis decidua
=*Capparis aphylla*

Malvaceae:
B. ceiba L.
=*Bombax malabaricum*
Urena lobata
Malvastrum sp.

Tiliaceae:
Grewia sp.

Meliaceae:
Melia azadirachta L

Rhamnaceae:
Z. mauritiana Lamq
=*Zizypus* jujuba

Anacardiaceae:
Anacardium occidentale L.
Mangifera indica L.

Moringaceae:
Moringa spp.

Papilionaceae
Derris indica (Lamk) Bennett
=*Pongamia glabra*
Tephrosia purpurea (L.) Pers.
Alysicarpus rugosus (Willd) DC
Crotolaria sp.
Vigna trilobata (L.) Verdl.
=*Phaseolus trilobus*
Sesbania bispinosa (Jacq.) Wight
=*Sesbania aculeata*
Smithia sp.
Desmodium gangeticum (L.) DC

Caesalpinaceae :
Delonix regia (Hk.) Raf
Tamarindus indica L.
Cassia tora L.
Cassia siamea Lamk

Myrtaceae:
Eucalyptus sp
Syzygium cumini (L.) Ske

Lythraceae:
Ammannia sp
Ammania hispida
Woodfordia fruticosa

Apocynaceae:
Plumaria rubra L.

Compositae:
Tridax procumbens L.
Bidens biternata (Lour) Sherff)
Sphaeranthus indicus L.
Vernonia dioergens

Asclepiadaceae:
Cryptostegia grandiflora Br.

Boraginaceae:
Trichodesmum hispidum

Convolvulaceae:
Ipomoea sp.

Scrophulariaceae:
Sopubia delphinifolia
Celsia coromandelina

Acanthaceae:
Hygrophila auriculata (Schum.) Heine
=*Asteracantha longifolia*

Verbenaceae:
Vitex negundo L
Clerodendron inerme (L.) Gaertn.
Avicennia alba

Labiatae:
Ocimum plabejum

Amaranthaceae:
Achyranthus aspera L.

Euphorbiaceae:
Euphorbia hirta L.
Jatropha curcas L.

Orchidaceae:
Vanda roxburghii Br.

Dioscoreae:
Dioscorea bulbifera L.

Palmae:
Cocos nucifera L.
Borasus flabeilifer L.
Caryota urens

Eriocaulaceae:
Eriocaulon sp

Cyperaceae:
Fimbristylis cymosa R. Br.
F. dichotoma (L.) Vahl.

Graminae:
Themeda fruandra
Lachemum sp.
Cynadon dactylon L.

7. Floristics of Thane District

Thane district is partly maritime and partly hilly. The monsoon ephemeral flora occurs on the hill tops and slopes. It consists of grasses and *Impatians balsamina, Polygala chinensis, Linum mysorensis, Clitoria biflora, Crotolaria* sp., *Pimpinella hyeneana, Bidens biturnata, Tridex procumbens, Buchnera hispida, Rhamphicarpa longiflora Sopubia delphinifolia, Torenia indica, Nauracanthus sphaerostachya, Celosia argentia, Euphorbia* sp. *Phyllanthus* niruri etc.

Southern Tropical semi-evergreen forests.—These occur in patches between 550—1400 m altitude at Murbad, Tokawada and Vashala ranges and on the slopes of Tungar hill. It generally occurs along the ghats. On the lower slopes they are mixed with deciduous species such as *Schleichera oleosa, Terminalia crenulata, T. chebula, Ixora brachiata, Carvia callosa, Bridelia squamosa.* On the hills *Memecylon umbellatum* occurs in pure patches. Shrubs of *Eleagnas conferta, Acacia torta, Colebrokia oppositifolia, Cappris rotundifolia, Ventilago bombaiensis, Carissa congesta* occur on lower slopes. There is also a herbacious layer. During rainy season in open rocky situation consisting of *Smithia purpurea, Smithia bigemina, Heracleum* sp. *Cynotis tuberosa, Habenaria grandiflora, Leucas* sp. besides *Swertia minor, Orosera indica, Exacum pedunculatum,* some grasses and *Cyperus pumilum, Eriocaulon dianas.* There is also a compact colony of *Centratherum phyllodae* and *C. tenue.* In ponds typical aquatic vegetation is seen as elsewhere with the addition of aquatic fern *Ceratopteris thallictroides.* There are many weeds in open unfertile and shallow lands.

In general the vegetation in the five districts of Konkan is more or less similar except in the southernmost part of Sindhudurg district in Amboli ghat and Phonda ghat belt. The change in vegetation north to south is gradual. The slopes of northern part are covered with deciduous forests along the lower slopes. They gradually merge into semi-evergreen forest in the southern part. Giant trees of real evergreen forest like *Hydnocarpus laurifolius, Calophyllum elatum, Hopea wightiana, Canarium strictum, Mammea surihega* do not occur here.

Analysis of Angiosperm families in Thane :

Bilore (1974) who worked on Thane flora furnishes first-hand information as noted below. He found that there are 74% dicots and 16.34% monocots, spread over 105 families of angiosperms, 572 genera and 989

species including naturalised and exotic ones. The ratio of dicots to monocots is 31·1. The principal families are :

Families	Genera	Taxa
Poaceae	69	118
Fabaceae	83	86
Asteraceae	31	52
Euphorbiaceae	21	39
Acanthaceae	22	36
Rubiaceae	18	29
Convolvulaceae	11	29
Orchidaceae	14	28
Scrophulariaceae	15	25
Lamiaceae	15	23
Asclepiadaceae	14	28
Verbenaceae	9	16
Malvaceae	10	15
Gentianaceae	7	14
Commelinaceae	4	14
Boraginaceae	9	13

Dominant genera are 22, having 6 or more than 6 species. They are as under :—

Cyperus	(21)
Crotolaria	(16)
Ipomoea	(15)
Euphorbia	11+2 cultivated
Ficus	(10)
Fimbristylis	(10)
Isachnemum	(10)
Blumea	(9)
Desmodium	(8)
Eragrostis	(8 each)
Indigofera	(7)
Smithia	(7)
Commelina	(7)
Eriocaulon	(7)
Cassia	(6)
Lindernia	(6)
Dioscorea	(6)
Arthraxon	(6)
Bothriochloa	(6)
Acacia	(5)
Sida	(5)
Scirpus	(5)

8- Thermal Springs of Vajreshwari and Algae therein

They are a novel feature of these districts. The hot water springs have their own flora, almost entirely composed of Algae. They belong mainly to Myxophyceae. They are of considerable interest in as much as they can grow in water having a range of temperature 60-70 °C. They have attracted attention of geologists since long (Bocst G, 1891, On vulcanoes in India. *Trans. Bom. Geo. Soc.* Vol. 10, Oldham T. 1882 ; *The thermal springs of India. Mem. Geol. Surp. India* Vol. 19). Oldham found not less than 301 such groups of hot springs in India ; in Konkan alone 23. They not only occur at Unabdev in district Jalgaon and in Konkan, but also in south coast and in Gujarat at Unai. Generally the temperature of water depends upon the depth from which the springs arise. Out of the 23 springs in Konkan some occur nearby Vajreshwari near Bombay. They have been studied by Professor Ella Gonzalves (1947). They are 77 km. from Bombay. They occur on either side of river Tansa. Sometimes they occur in the river bed itself. There are 3-4 groups of them having more than 20 springs. The temperature of the largest spring here was 57.0 °C. It occurs in a circular pool, 6 feet in diameter and 3-4 feet deep. Clear water gushes out from it nearly 30 gallons per minute. The underlying rock is basalt and laterite, often badly decomposed due to hot water. A number of algae occur here. *Anabaena* grows by sides of the pool having a temperature 57.5°C. They never bear spores. *Phormidium africanum* thrives at 55°C. It grows between 40°C and 55°C. On the other hand *Phormidium orientale* occurs between 38-49°C. *Plectonema gracillimum* occurs at 49°C but not at lower temperature. *Oscillatoria jasoruensis* grows between 40-49°C. Common algae here are the colonial *Oscillatoria* and *Aphanotheca thermalis*. They grow between 47-49°C. Colonies of these may be small or large. *Lyngbya putealis* occurs between 40-45°C. At lower temperatures also some other algae are found here. They are *Spirulina subsalse* Derst, *Oscillatoria proboscides* Gomb, At 38°C between 34-36°C *Scytonema tolypothrixhoides Lyngbya aestuarii* (Murt.) Lieb. *forma spectabilis* Comb., *Gleocapsa granosa* (Burk.) Kutz, *Anabaena orientalis* Dixit, *Aulosira bombaensis* and two diatom sp. Of these *Gleocapsa granosa* only forms spores, like *Nitzschea thermalis* and *Rhopaloidia jibberula* . Of these only *Phormidium africanum* was common in almost every spring or in the overflowing water having a temperature 40-54°C. The others are *Phormidium orientale* and *Oscillatoria jasoruensis.*

Probably the *Phormidium orientale* and *Aphanocapsa thermalis* are real thermal forms because all others are also found in cold waters, but not these two algae.

Systematic enumeration of the thermal species of Cynophyceae is given below.

I. Order—Chroococcales:

Family—Chroococcaceae:

1. *Aphanotheca thermalis* Brug. occurs with *Phormidum africanum*
2. *Gleocapsa granosa* occurs at 34°C on the walls of a tank with *Aulosira bombayensis.*

II. Hormogoniales:

Family—Microchaetaceae

3. *Aulosira bombayensis* Gonz. on the walls of the tanks with water at 34°C.

Family—Scytonemaceae:

4. *Plectonema gracillimum* in the tank of the temple of Vajreshwari growing at the temperature 29°C.
5. *Scytonema tolypothrichoides* in overflow waters at 36°C.

Family—Nostocaceae:

6. *Anabaena* species.—This grows in the hottest spring at 57.5°C
7. *Anabaena orientalis* Dixit growing in overflow water at 34°C.

Family—Oscillatoriaceae .

8. *Spirulina subcetosa* grows with *Oscillatoria proboscides* at 58°C temperature in overflow water.
9. *Oscillatoria proboscides* in the overflow at 38°C.
10. *Oscillatoria jasorvensis* in the overflow at 40-49°C.
11. *Phormidium africanum* in overflow of various spring at 40-54°C temperature.
12. *Phormidium orientale* in overflow water between 38.49°C.
13. *Lyngbya aestuarii* in overflow between 34-36°C.
14. *Lyngbya putealis* in temple tank and overflow at 40-45°C.

III. Order—Pennales, Bacillariophyta (Diatomaceae)
Family—Epithemaceae :

15. *Rhopalidia gibberula* in overflow spring at 40°C.
16. *Nitzschiela thermelis* in overflow water of spring above 40°C.

[For details see Gonzalves E, 1947—*Jour. Univ. Bombay* Vol. 16 (3) : 22—27].

The thermal springs at Mahad and other places have not been investigated.

Thermal Algae

	Name	Locality
	Chroococcaceae	
1	*Gloeocapsa granosa* (Bork) ..	Found in hot water springs at Vajreshwari growing at a temperature 34°C.
2	*Aphanocapsa thermalis* (Kutz) Prugg. ..	Vajreshwari.
	Hyellaceae	
3	*Spirulina subsalsa* Gerst ex Gomont.	Vajreshwari.
4	*Oscillatoria chalybea* (Nestena) Gomont.	Bombay, Vajreshwari.
5	*Phormidium africanum*	at 40 to 50°C. Vajreshwari
6	*Lingbya putealis* Monl. ex Gomont	at 40-45°C at Vajreshwari.
7	*Anabaena orientalis* Dixit ..	Vajreshwari.
8	*A. burlayensis* Gonzalves ..	Vajreshwari.
9	*Plectonema gracillimum* Zopf Hansgirg.	Vajreshwari.

9. Grasses and Fodder Plants of Thane and other places in Maharashtra

Grasslands constitute a very distinctive feature of Thane district and some other places in Maharashtra like Talegaon or Katraj. The principal areas conserved are in Thane, Pune, Khandesh and Melghat. They generally grow together with wild legumes such as *Crotolaria linifolia* L, *Crotolaria triguetra* Dalz, *C. filipes* Benth. *Smithia sensitivium* Ait, *Alysicarpus lagenaris* DC, *Indigofera tinctoria* L, *Heylandia latebrosa* DC. Together they make excellent pastures. The main species of grass are *Ischaemum ciliara* Retz, *Heteropogon contortus* L., *Themeda quadrivalvaris* Ok. *Pseudanthis sp.*, *Arundinella tenella*, *Dichanthium annulatum* Stapf, *Eulalia fibriata* Sl. and Mc. Occasionally seen are *Panicum antidotala, Pennisetum species. Iseilema wightii, Cloria monolyana, Tricholaena repens, Penicum variagatum, Eragrostis superba, Eragrostis curvila, Pennisetum polystachyon, Ischaemum sulcatum, I. laxum, Andropogon monticola, A. pertusus, Dicanthium curiosum.*

In Thane they extend from Raita to Palghar, Umbergaon including Dahanu and Kosbad. A lot of work on their agronomy, improvement, regeneration of grasslands, has been done in Maharashtra.

On the escarpments of Sahyadri ranges to the west in Konkan, especially in the ghat sections, only grasses grow. In Khandesh they grow around Dhule. The rainfall at these four centres of grasslands is not the same nor are the soils. Naturally grass species in each of these areas are different. Many new species such as Gayana grass, Para grass 'Gaja-Raj' have been introduced. A booklet '*Review of Research on Grass Lands : Forage and Fodder Crops*' is published by the Agricultural Department of Maharashtra, which may be consulted for details.

A list of grasses in Thane are given below :—

9.1. *Wild Grasses of Thane* :—

I. Dry stock farm, Site I, Palghar :

Perennial grasses :

Dichanthium caricosum
Imperata cylindrica
Ischaemum indicum
I. pilosum
Iseilema prostratum
Sorghum halipense
Themeda triandra.

Annual grasses :

Apluda mutica
Arundinella metzii
A. pumila
Chionochne koenigii
Coix lacrymajobi
Pseudanthistrics hispida
Setaria glauca
Themeda quadrifolia
Themeda triandra.

Herbs—

Alysicarpus longifolius
Atylosia scaraboeoides
Crotolaria sp.
Desmodium diffusum
Hibiscus sp.
Indigofera linifolia
Justicia betonica
Phaseolus sp.
Sesbania bispinosa

Shrubs and trees in grass—

Acacia catechu
Butea monosperma
Ziyzphus sp.

II. Dry stock Farm, Site II, Palghar:

Perennial grasses—

Dichanthium annulatum
D. caricosum
Ischaemum indicum
I. pilosum
Iseilema prostratum
Ophiurus exaltatus

Annual grasses—

Arundinella metzii
A. pumila

Herbs—

Crotolaria sp.
Desmodium diffusum
Indigofera hendecaphylla Jacq.

Shrubs—

Butea monosperma
Carissa carandus
Zizyphus mauritiana

III. At Kamarabagh, Palghar:

Perennial grasses—

Dichanthium annulalum:
D. caricosum
Ischaemum indicum
Iseilema laxum

Annual grasses—

Apluda mutica
Brachiaris ramosa
Eragrostis tanella

Herbs—

Corchorus sp.
Crotolaria sp.
Desmodium diffusum
Euphorbia hirta

Shrubs and trees—
Bauhinia sp.
Zizyphus sp.

IV. In Reserved Forest. North Thane Division, Palghar :

Perennial grasses—
Ischaemum indicum
Tripopogon ramosissimus

Annual grasses—
Arundinella pumila
Eragrostis diarrhena
Ischaemum semisaqittatum
Pseudanthistiria umbellata
Themeda quardivalvia

Herbs—
Cassia tora
Crotolaria sp.
Mucuna sp.

Shrubs and trees—
Tectona grandis

9.2. *Cultivated grasses of Thane for fodder and other purposes*

Out of the above list the following grasses are cultivated for fodder and other purposes. Their use is shown against their names :—

1. *Cymbopogon martianii* .. .. Grown for fodder.
2. *Cynodon dactylon* .. .. Do.
3. *Echinochlos colonum* .. .. Do.
4. *Eleusine coracana* .. .. Do.
5. *Ischaemum indicum* .. .. Do.
6. *Ischaemum tumidum* stafex .. Do.
7. *Pseudanthistiris heterociliata* .. The best fodder grass.
8. *Sacciclepis interrupta* .. .. For fodder.
9. *Neyrandis arundinacea* .. .. Do.
10. *Arundo donax* .. .. .. Do.
11. *Oryza sativa* .. .. .. Grown as paddy.
12. *Panicum sumatranse* .. .. Grown for grain used by Adivasis as food.
13. *Eulaliopsis birawta* .. .. Used in paper industry.

9.3. *Flora of Ulhasnagar*

Ulhasnagar is situated about 58 km. away from Bombay. It is situated on Waldhuni and Ulhas rivers lying 19°.12' N. Lat. and 73° East Long. near the foot of Haji Malang range of Sahyadris. It is only about 9 metres above the sea level, having 2,540 mm. of rainfall, mostly in the months June and September. The maximum temperature is 31°C. The soil is lateritic or derived from gravel and hard sandstone. In monsoon annual herbs grow on them and a few liverworts like *Riccia*, *Cyathodium Anthoceros* and *Notothylas* species. A species of *Selaginella miniatospora*, *Marsilea quadrifolia* and two species of *Adiantum* are

common. *Ceratopteris thalictoroides* grows in marshy places. About 160 species belonging to 57 families have been recorded by Dr. G. T. Dabhade of Thane College. Noteworthy among them are *Thespesia paopulnea, Garuga pinnata, Zizyphus rugosa, Woodordia fruticosa, Jussiaea suffruticosa Dentella repens, Sphaeranthus indicus Clerodendron phlomoides, Aeridis crospun* (an orchid) and the three usual palms *Phoenix sylvestris, Borassus flabellifer* and *Cocos nucifera. Malachra capitata* is rampant in marshes and a few mangroves. The flora appears to be a mixture of marsh and dry species.

Name	Locality
Anonaceae :	
Anona squamosa L.	
Polyalthia longifolia Benth. and Hook.	
Menispermaceae :	
Cocculus villosus DC	Waldhuni river bank.
Papaveraceae :	
Argemone mexicana L.	
Cruciferae :	
Brassica nigra Koch.	Near Ulhasnagar railway station.
Brassica oleracea L.	Waldhuni river bank and Ulhasnagar College campus.
Raphanus sativus L.	Waldhuni river bank and Ulhasnagar College campus.
Capparidaceae :	
Cleome viscosa L	Waldhuni river bank.
Portulacaceae :	
Portulaca oleracea L.	Waldhuni river bank.
Malvaceae :	
Hibiscus rosa-siensis L.	
Hibiscus esculantus L.	Vithalwadi Rly. station.
Sida acuta Burm. f.	Vithalwadi Rly. station.
Sida cordifolia Lam.	
Sida veronicifolia Lam.	Ulhasnagar Rly. station.
Sida rhombifolia L.	Vithalwadi Rly. station.
Malachra capitata L.	Waldhuni river bank, Vithalwadi Rly. station, Ulhasnagar Rly. station.
Urena lobata L.	Waldhuni river bank, Vithalwadi Rly. station, Ulhasnagar Rly. station.
Thespesia populnea Soland ..	Ulhasnagar College campus.
Bombaceceae :	
Bombax ceiba L.	
Starculiaceae :	
Gauzuma tomentosa H. B. and K.	Ulhasnagar Rly. station.
Tiliacaeae :	
Chorchorus olitorius L.	Vithalwadi Rly. station.
Burseraceae :	
Garuga pinnata Roxb.	

Name	Locality
Meliaceae :	
Azadirachta indica Juas.	
Rhamnaceae :	
Zizyphus jujuba Lam.	
Zizyphus oenoplia Mill.	
Zizyphus rugosa Lam.	Waldhuni river bank.
Anacardiaceae :	
Mangifera indica L.	
Moringaceae :	
Moringa pterygosperma Gaert.	
Papilionaceae :	
Crotolaria pusilla Heyne	Vithalwadi Rly. station.
Indigofera linifolia Retz.	Vithalwadi Rly. station.
Tephrosia tinctoria Pers.	Waldhuni river bank.
Smithia bigemina Dalz.	Vithalwadi Rly. station.
Smithia sensitiva Ait.	Waldhuni river bank.
Aeschyomene indica L.	Waldhuni river bank.
Alysicarpus vaginalis DC. ..	Vithalwadi railway station, Ulhasnagar railway station.
Desmodium triflorum DC.	
Abrus precatorius L.	Waldhuni river bank.
Phaseolus mungo L.	Ulhasnagar railway station. Waldhuni river.
Pongamia pinnata Pierre	
Caesalpinaceae :	
Caesalpinia pulcherrima Swartz.	
Tamarindus indica L.	
Mimosoideae :	
Mimosa pudica L.	Ulhasnagar College campus,
Cassia tora Bak.	Vithalwadi railway station.
Acacia arabica Willd.	Vithalwadi Rly. station.
Acacia catechu Willd.	
Crassulaceae :	
Bryophyllum calycinum Salisb. ..	Ulhasnagar College campus.
Myrtaceae :	
Eugenia jambolana Lamk.	
Lythraceae :	
Woodfordia fruticosa Salisb. ..	Ulhasnagar railway station.
Lawsonia alba Lamk.	
Ageratum conyzoides L.	
Cyathocline purpurea (Don) D. Kuze.	Waldhuni river. Vithalwadi railway station,
Blumea wightiana DC.	
Sphaeranthus indicus L.	
Gnaphalium luteoalbum L.	
Caesulia axillaris Roxb.	Vithalwadi railway station.
Xanthium strumarium L.	Ulhasnagar railway station.
Eclipta alba Hassk.	Waldhuni river bank.
Blainvillea latifolia (Linn.). DC.	
Tridex procumbans L.	
Launea nudicaulis Hook.	

Name	Locality
Oleaceae :	
Jasminum grandiflorum L.	
Apocynaceae :	
Nerium odorum Sol.	
Thevetia nerifolia Juss.	
Asclepiadaceae :	
Calotropis gigantea Br.	Ulhasnagar railway station.
Cryptolepis buchananii R. Anders	
Gentianaceae :	
Canscora diffusa R. Br.	Ulhasnagar railway station.
Boraginaceae :	
Trichodesma indicum R. Br.	Ulhasnagar railway station.
Cordia dichotoma Forsst.	
Heliotropium indicum L.	Waldhuni river bank.
Convolvulaceae :	
Ipomoea campanulata L.	Ulhasnagar College campus.
Ipomoea aquatica Forsk.	Waldhuni river bank.
Quamoclit vulgaris Chois.	Ulhasnagar railway station.
Quamoclit phoenicea Chois.	Ulhasnagar College campus.
Cuscutaceae :	
Cuscuta reflexa Roxb.	
Solanaceae :	
Solanum xanthocarpum Schd. and Wendl.	Vithalwadi Railway station.
Datura fastuosa L.	
Solanum nigrum L.	
Physalis minima L.	Waldhuni river bank.
Scrophulariaceae :	
Lindenbergia urticaefolia Link.	
Bonnaya oppositifolia Spreng.	
Pedaliaceae :	
Sesamum indicum L.	Waldhuni river bank.
Martynia diandra Glox.	Ulhasnagar railway station. Waldhuni river bank.
Acanthaceae :	
Asteracantha longifolia Nees.	
Lepidagathis cristata Willd.	Vithalwadi railway station,
Justicia simplex Don.	Waldhuni river bank. Vithalwadi railway station.
Adhatoda vasica Nees	
Peristrophe bicalyculata Nees	Ulhasnagar and Vithalwadi railway stations.
Rungia pactinata Clarke	Waldhuni river bank. Vithalwadi railway station.
Vitex negundo L.	
Tectona grandis L. f.	
Lantana camara L.	
Lippia nodiflora Mich.	
Clerodendron phlomoidis L.	
Labiatae :	
Anisomeles ovata Br.	Ulhasnagar railway station.
Ocimum sanctum L.	

Name		Locality
Nyctaginaceae :		
Boerhaavia diffusa L.		
Bougainvillaea spectabilis Willd.		
Amaranthaceae :		
Amaranthus paniculatus L.	..	
Amaranthus viridis L. ..	..	Vithalwadi railway station.
Celosia argentea L. ..	..	
Achyranthes aspera L. ..	..	
Aerua scandena Wall. ..	..	Ulhasnagar.
Aerua lanata Juss. ..	..	
Gomphrena globosa L.		
Alternathera sessilia R. Sr.	..	Waldhuni river bank.
Chenopodiaceae :		
Chenopodium album L. ..	..	Waldhuni river bank.
Polygonaceae :		
Polygonum glabrum Willd.	..	Waldhuni river bank. Vithalwadi railway station.
Loranthaceae :		
Dandropthoe falcata Kurz.		
Euphorbiaceae :		
Euphorbia nerifolia Dalz.		
Phyllanthus niruri L. ..	..	Waldhuni river bank. Vithalwadi railway station.
Euphorbia hirta L. ..	..	Waldhuni river bank.
Phyllanthus reticulatus Poir.	..	Do.
Moraceae :		
Ficus glomerata Roxb		
Ficus religiosa L.		
Ficus bengalensis L.		
Casuarinaceae :		
Casuarina equisetifolia Forst.		
Hydrocharitaceae :		
Hydrilla verticillata Presl.		
Orchidaceae :		
Aerides crispum Lindl. ..	..	
Amaryllidaceae :		
Agave americana L.		
Liliaceae :		
Aloe vera L.		
Pontaderiaceae :		
Monochoria hasteafolia Prasl.		
Commelinaceae :		
Commelina benghalensis L.	..	Waldhuni river bank. Ulhasnagar railway station.
Commelina forskalii Vehl.	..	Ulhasnagar railway station. Waldhuni river bank.
Cyanotis fasciculata Schultz	..	Ulhasnagar railway station.
Aneilema spiratum Br. ..	..	Ulhasnagar railway station.
Palmae :		
Phoenix sylvestris Roxb.		
Borassus flabellifer L.		
Cocos nucifera L.		

Name		Locality
Pandanaceae :		
Pandanus odoratissimus L.		
Cyparaceae :		
Cyperus rotundus L.	..	Waldhuni river bank.
Gramineae :		
Saccharum officinarum L.	..	Waldhuni river bank.

10. Flora of Raigad District

Raigad district is adjacent to Thane, Greater Bombay and Ratnagiri. The Fitzgerald ghat joins it to Mahabaleshwar *via* Poladpur. Kolaba, now named Raigad, is a maritime district with Alibag as its headquarters. It is a rugged country not much above the M. S. L. Long ranges of Sahyadri run through it and are densely covered with scruby vegetation and low dry deciduous trees. Parts at the foot of Sahyadris on the western side such as Pali, Mahad, Poladpur, Khopoli have deciduous forests. The beautiful hill station of Matheran is in Raigad district. Much of the vegetation on the sea side contains many groves of coconut and areca palms. *Borassus* is there but not common. No authoritative district flora has yet been written, but from what is known so far it is of the same type of flora as in Thane. Only flora of Matheran and the hill fort of Raigad are known and they give idea of vegetation to the west of Sahyadris in this district. It contains a few moist deciduous species like *Garcinia indica* which are confined to the hill tops. The portion near Alibag and Shrivardhan presents a park-like appearance due to intensive cultivation and many *wadis* full of coconut and *Areca* palms.

Flora of Matheran and Raigad fort has been worked out by Cooke (1887), Birdwood (1886) and of Raigad fort by Vartak (1966). The Matheran flora represents a typical hill flora of low altitude in Sahyadri ranges and of low hills in Konkan facing Arabian sea to the west. Both are significant promontaries in Raigad district and have characteristic vegetation. Raigad's vegetation is partly unlike that of other hill forts like Sinhgad, Purandar and Torna which lie on the leeword or Desh side of Sahyadris. In this connection, the flora of Sinhgad, Torna and Purandar may be compared with it, and contrast noted.

10·1. Flora of Matheran :

One of the special features of Western Ghats is the disconnected upland plateaus on the peaks of Sahyadris. This has given rise to a number of hill stations on their highest positions. Matheran is one of them and is close to Bombay and Kalyan. The highest point of Matheran is about 2500′ above the sea level. It has a number of plants common to the ghat forests, on its topmost parts. Some of them are found only at Matheran. Cooke mentions that the flowering plants including a few grasses found here, are 170. About 130 plants of Mahabaleshwar do not occur on the Matheran plateau. Not less than seven species of *Strobilanthes* occur here. The vegetation is of the monsoon deciduous type in which some species of *Garcinia*, 24 species of ferns and 9 species of mosses grow at Matheran. Bushes of *Ligustrum nilghirense*, *Salix tetrasperma* found at Mahabaleshwar are also found at Matheran. *Golchidion species* and *Flacourtia montana*, *Kydia calycina*, *Artocarpus insignis* are pretty common. On southern slopes we get some thorny bushes, but on the eastern slopes down the valley near Ramghat, there is a fairly thick forest in which some tall creepers such as *Celastrus*

paniculatus and a number of ferns grow and also at its base. There is no dense vegetation at Matheran, because the flora is mostly on the western and northern side where the escarpment of rocks is 60 to 90 metres straight down. In the vegetation on the western side of the hill there are mostly grasses.

The important Matheran flora lies in the forest on the crest of the hill on the western side of Sahyadris. It has some plants which are not to be seen elsewhere. That is why a number of plants are localised and endemic. They possibly illustrate the process that must have been at work for a long time in the forests of Maharashtra. The only other similar situation is met with in the flora of Raigad forest lying to the west of Sahyadris.

The following two lists give plants found at Matheran. They are old but have not been succeeded by better and recent ones.

10·2. List of plants of Matheran after Birdwood (1886) *and Cooke* (1887)

Species	Flowering season
Ranunculaceae :	
Clematis gouriana Roxb.	October-November
Dilleniaceae :	
Dillenia pentagyna Roxb.	March-April
Menispermaceae :	
Cocculus macrocarpus Wight	February-March
Papavaraceae :	
Argemone mexicana Linn.	All the year
Capparidaceae :	
Capparis pedunculosa Wall.	March
Guttiferae :	
Garcinia indica Choisy	November—February
G. spicata Hook. var *macrantha*	December-January
Malvaceae :	
Ancistrocladus heyneanus Wall	
Hibiscus hirtus Linn.	October—January
H. vitifolius Linn.	October—December
H. tetraphyllus Roxb.	October
Sterculiaceae :	
Sterculia urens Roxb.	December—February
Tiliaceae :	
Grewia polyantha Roxb.	September—November
Erinocarpus nimmonii Grah.	August-September
Corchorus acutangulatus Lam.	September
Malphigiaceae :	
Aspidopterys cordata Jun.	September—November
Geraniaceae :	
Impatiens acaulis Arn.	September—November
Rutaceae :	
Murraya exotica Linn.	June—October
Bursaraceae :	
Canarium strictum Roxb.	February—April

Species	Flowering season
Meliaceae :	
Cedrela toona Roxb.	January
Celastraceae :	
Celastrus paniculata Willd.	November—February
Gymnosporia pubenula Laws	April—June
Hippocratea grahamii Wight.	January—April
Rhamnaceae :	
Zizyphus xylopyrus Willd.	
Sapindaceae :	
Hemigyrosa canescens Thwaics	February—May
Schleichera trijuqa Willd.	February—May
Sapindus laurifolius Vahl.	October—December
Leguminaceae :	
Smithia sensitiva Act.	September-October
Desmodium cephalotes Wall.	
D. laxiflorum DC.	August—October
D. triquetrum DC.	September—December
Shuteria vestita Wight and Arn.	October
Erythrina stricta Roxb.	February—May
Atylosia lineata Wight	October—December
Cylista scariosa Roxb.	November—February
Flemingia strobilifora R. Br.	November—January
Dalbergia torta Graham	June
D. sympathetica Nimmo	February—March
D. paniculata Roxb.	April-May
Caesalpineae :	
Mezoneuron cucullatum Wight	September—October
Bauhinia foveolata Dalz.	September—October
Mimoseae :	
Acacia concinna DC.	March—July
Albizzia stipulata Boivin	April—June
A. amara Boivin	April—June
Crassulaceae :	
Bryophyllum calycinum Salirb.	January
Rhizophoraceae :	
Carallia integerima DC.	December—March
Calycopteris floribunda Lamk.	March—May
Anogeissus latifolia Wall.	May—July
Myrtaceae :	
Careya arborea Roxb.	March-April
Lythraceae :	
Lagerstroemia parviflora Roxb.	June
Onagroceae :	
Ludwigia parviflora Roxb.	May-June
Samydaceae :	
Casearia graveolens Dalz.	August—January
Cucurbitaceae :	
Dicoelospermum ritchiei C. B. darke	July—September
Umlelliferae :	
Hydrocotyle asiatica Linn.	May—November
Peucedanum grande C. B. clarke	July

Species	Flowering season
Rubiaceae :	
Hymenodictyon excelsum Wall.	June—August
H. obovatum Wall.	July—September
Anotis rheedei Banth.	July
Mussaenda frondosa Linn.	July—October
Randia dumetorum Lamk.	March—June
=*Xeromphis* spinosa	
Vongueria spinosa Roxb.	January—April
Ixora parviflora Vahl.	January—April
Pavetta indica Linn.	March—May
Phispidula Wightii	May
Compositeae :	
Vernonia cinerea Len.	January-February
Elephantopus scalees Linn.	September—November
Blumea wrightiana DC.	December-January
Blumea belangariana DC.	December—March
B. malcolnii Hook	November—February
Genaphelium indicum Linn.	December—March
Vicoa cernua Dalz.	November—February
Xanthium strumarium Linn.	January-February
Campanulaceae :	
Lobelia nicotianaefolia Heyne	November—March
Wahlenbergia gracilis Schrad.	December—February
Sapotaceae :	
Sideroxylon tomentosum Roxb.	October—January
Bassia latifolia Roxb.	January—April
Mimusops elengi Linn.	January —March
Ebenaceae :	
Diospyros sylvatica Roxb.	January-February
Oleaceae :	
Jasminum malabarioum Wight.	May-May
Olea dioica Roxb.	January—April
Apocynaceae :	
Alstonia scholaris R. Br.	December—March
Holarrhena antidysenterica	February—June
Ervatamia heyneana T. cooke	March-April
Wrightia tinctoria R. Br.	March—May
Anodendron paniculatum DC.	December—March
Asdepiadaceae :	
Calotropis gigantea R. Br.	February—July
Holostema rheedianum Spreng	July-August
Loganiaceae :	
Fagraea obovata a Wall	July
Strychnos colubrina Linn	October—January
Conscora diffusa R. Br.	October—January
Boraginaceae :	
Cordia myxa Linn.	March—April
Ehrelia laevia Roxb.	January—June
Convolvulaceae :	
Cuscuta reflerxa Roxb.	January-February
Porana malabarica C. U. clarke	October
Evolvulus alsinoides Linn.	July—November
Opercularia turpethum silva Maro	October—January

Species	Flowering season
Argereia sericea Dalz.	September-October
Lettsomia setosa Roxb.	September—December
Scrophulariceaceae :	
Limnophila racemosa Benth	November—January
L. qatripleides R. Br.	November—January
Striga orobanchioides Benth	October-November
Rhamphicarpa longiflora Benth. ..	October-November
Sopubia delphinifolia G. Don. ..	August—October
Centranthera hispida R. Br.	September-October
Lentibulariaceae :	
Artricularia flexuosa Vahl.	November
Bignoniaceae :	
Heterophragma roxbrughii DC. ..	February—April
Acanthaceae :	
Daedalacanthus roseus T. Anders ..	November—January
D. purpuras cens T. Anders	November—January
Strobilanthes heyneanus Nees.. ..	October—December
S. perfoliatus T. Anders.	
Calacanthus dalz elliana T. Anders ..	October—December
Haplanthus verticillaris Nees ..	December
Barleria prionitis Linn.	October—January
B. lauri T. Anders.	October
Bistigosa Willd.	November—December
Asystasia violacea Dalz.	November
Lepidagathis cuspidatus Nees.	March
Rungia parviflora Nees.	November—February
Dicleptera zeylanica Nees.	December—March
Ecbolium linneanum Kurz.	October—January
Justicia betonica Linn.	October—December
J. trinervis Vahl.	October—January
Verbenaccae :	
Callicarpa lanata Linn...	December—April
Labiateae :	
Pogostemon purpurasens Dalz. ..	October—January
Anisomeles heyneana Benth.	October-November
A. ovata R. Br.	August—October
Leucas stelligera wall	November
Piperaceae :	
Piper trichostachyon Can.	
P. hookeria Mig	April—September
Lauraceae : ..	
Machilus macrantha Nees.	December—March
Alseodaphne semicarpifolia Nees. ..	July—December
Actinodaphne hookeri Meissn. ..	November
Elaeagnaceae :	
Elaeagnus latifolia Linn.	November—January
Loranthaceae :	
Loranthus cuneatus Heyne	April-May
Loranthus laginiflorus wight	April-May
L. capitellatus Wrght	February—May
Euphorbraceae :	
Bridelea hamiltomiana Wall.	August—November
Phyllanthus emblica Linn.	March—May

Species	Flowering Season
P. wrinaria Linn.	August
Croton reticulatus Heyne	October—January
Dimorphocalyx laurianus Hook.	March—October
Mallotus lamii Mudl.	October—January
Macaranga tomentosa Wight	January—March
Tragia involucrata Linn.	November-December
Urticaceae :	
Trema orientalis Blume	Throughout year
Fleurya interrupta Gand.	August
Lecanthus wightii Wedl.	September-October
Ficus arnottiana Mrg.	February—April
Burmanniaceae :	
Burmannia caelestis Doc.	September
Orchidaceae :	
Dendrobium barbatulum Lindl	April-May
Thunia venosa Rolfe	July-August
Platanthera susannae Lindl.	September
Habenaria plantaginea Lindl	March-April
Commlinaceae :	
Commeelina clavata Clarke	
Aneilema paniculatum wall	August
A. vaginatum R. Br.	August
Palmeae :	
Phoenix sylvestris L.	January-February
Caryota urens L.	Flowers during most of the year.
Araceae :	
Amorphophallus commutatus Engler	May-June
Ariopsis peltata Nimmo.	June—September
Remusalia viripara Schott.	
Cyperaceae :	
Cyperus deformis Linn.	October—January
C. iria var. *paniciformis*	September
Gramineae :	
Oplismenus compositus Beaun.	November-December
Ischaemum diplopogon Hook.	
Arthraxon inermis Hook.	October
Tripogon capillatus Jaub.	September
T. jacquemontii Stapl.	

Name of the species	Flowering period (1897)
Ranunculaceae :	
Delphinium dasycaulon Fresen Cappari-deae.	August-September
Capparis horrida Linn. f. Bixaceae	November—April
Flacourtia montana Grah.	November-December
Guttiferae :	
Garcinia ovalifolia Hook. f.	
Dipterocarpaceae :	
Ancistrocladus hyneanus Wall.	March

Name of the species	Flowering period (1897)
Malvaceae :	
Urena sinuata Linn. DC.	October-November
Hibiscus hirtus Linn.	October—January
Kydia calycina, Roxb.	November
Sterculiaceae :	
Eriolaena stocksii, H.f.T.	
Tiliaceae :	
Erinocarpus nimmoanus Grah.	August-September
Lineaceae :	
Reinwardtia trigyna Hook.	January
Rutaceae :	
Murraya exotica Linn.	June—October
Burseraceae :	
Garuga pinnata Roxb.	February-March
Canarium strictum Roxb.	February—April
Meliaceac :	
Cedrela toona Roxb.	January
Celastrineae :	
Celastrus paniculata Willd.	November—February
Hippocratea grahami Wight	January—April
Rhamnaceae :	
Ventilago maderaspatana Goetn.	December—January
Zizyphus xylopyrus Wild.	May—July
Scutia indica Brongn.	February—April
Ampelideaceae :	
Leea sambucina Willd.	July—October
Sapindaceae :	
Allophylus cobbe, Blume	May—August
Schleichera trijuga, wild	February—May
Sapindus trifoliatus, Linn.	
Leguminosae :	
Desmodium cephalotes wall.	August—October
Erythrina stricta Roxb.	February—May
Dalbergia paniculata Roxb.	April-May
Rosaceae :	
Cotoneaster frigrda wall.	
Crassulaceae :	
Bryophyllum calycinum salisb.	January
Combretaceae :	
Anogeissus latifolia wall.	May—July
Cucurbitaceae :	
Hukia leiosperma Thwaites	
Rubiaceae :	
Anotis rheedii W. and A.	July
Mussaenda frondosa Linn.	October
Pavetta indica Linn.	March—May
Compositae :	
Elephantopus scaber Linn.	September—November
Pulicaria wightiana Clarke	

Name of the Species	Flowering period (1897)
Sapotaceae :	
Sideroxylon tomentosum Roxb. ..	October—January
Bassia latifolia Roxb.	January—April
Mimusops elengi Linn.	January—March
Oleaceae :	
Ligustrum neilgherrense Wight ..	August—November
Loganiaceae :	
Strychnos colubrina Linn.	October—January
S. potatorum Linn. f.	April-May
Gentianaceae :	
Exacum petiolare Griseb	
Canscora diffusa Br.	October—January
Boraginaceae :	
Cordia myxa Linn.	March-April
Ehretia laevis Roxb.	January—June
Trichodesma zeylanicum Br.	January
Convolvulaceae :	
Porana malbarica Clarke	October
Scrophulariaceae :	
Vandellia crustacea Benth.	August
Ilysanthes hyssopioides Benth. ..	October-November
Ramphicarpa longiflora Benth. ..	October-November
Centranthera hispida Br.	September-October
Bignoniaceae :	
Heterophragma Roxburghii DC. ..	February—April
H. ademophyllum Seem.	
Acantheaceae :	
Hygrophila serpillum T. Anders ..	September—January
H. Spinosa T. Anders	September—January
Doedalacanthus purpurasoens ..	November—January
Strobilanthes asper Wight	October
S. perboliatus T. Anders	December—March
Calacanthus dalzelliana T. Anders ..	October—December
Barleria prionitis Linn.	October—January
B. gibsoni Dalz.	September—November
B. grandiflora Dalz.	November
Justicia betonica Linn.	October—December
Myristicaceae :	
Myristica attenuata wall.	October—February
Lauraceae :	
Beilachmiedia bagifolia Nees.	
Dehaasia cuneata Blumer	
Alseodaphne semicarpifolia Nees. ..	July—December
Euphorbiaceae :	
Macaranga roxburghii Wight ..	
Salicineae :	
Salix tetrasperma Roxb.	October
Burmaniaceae :	
Burmania coelestris Don.	
Orchidaceae :	
Habenaria plantaginea Lindl.	

Name of the species	Flowering period (1897)
H. stenostachya Benth.	
H. wightii Trimen	
Commelinaceae :	
Aneilema pauciflorum Wight	
Cyperaceae :	
Cyperus difformis Linn.	October—January
C. iria, Linn.	December
C. tuberosus Rott.	
Gramineae :	
Pogonatherum saccharoideum Beauv. Beauv.	
Tripogon capillatus Jaub and Spoch.	September
Filicineae :	
Polypodiaceae :	
Polybotrya appendiculata, Willd.	
Gymnoptesis contaminans Wall.	
G. subreeta Hook.	

10.3. *Flora of Raigad Hill Fort*

Another significant promontory of Sahyadris, which had attracted the attention of botanists, is Raigad Fort. This is a strong hill-fort with significant vegetation different from that of other hill-forts like Sinhgad, Purandar and Torna. In this connection the account of flora of Purandar Fort given elsewhere be compared with that of Raigad.

It is situated between 18°.14' latitude North and 73 °30' East, 25.7 kilometres to the north of Mahad town. It was the capital of Shivaji from 1664 to 1680 A. D. It has scarped sides which isolate it from the surrounding country, and a flat top of about four kilometres. It is 2851′ above the M. S. L. It is 2.4 km. east-west and 1.6 km. north-south. Its south and east sides are extremely scrapped continuously, steep as those of Jibraltar rock.

The weather is sultry, coming up through Konzar valley 12.8 km. Raigad gives a panoramic view of the surrounding country and other hill forts like Pratapgad, Raigad and Torana. There are 10-12 lava flows separated by the bands of red and green earth or red-bole. The top-most layers are hard and compact. Many dykes and transverse joints pass through them allowing water to percolate, and to form lakes.

Vegetation on the top is of mixed deciduous type, and semi-evergreen type forest in the valleys. It is not much disturbed due to isolated position of the fort. The ravines below are full of it, consisting of *Terminalia paniculata, Terminalia crenulata, Bridelia squamosa, Lagerstroemia lanceolata, Gmelina arborea, Bombax cieba, Dillenia pentagyna, Fagara budrumga* and *Syzygium cumini*. The trees here form 40′ high canopy. They are mixed with small shrubs of *Randia brandisii, Ixora arborea, Allopyllus serratus, Bauhinia racemosa, climbers* like *Celastrus paniculata, Tinospora cordifolia, Zizyphus rugosa, Calycopteris floribunda,* etc. *Thespesia lampas* occurs here and there. The herebaceous flora is rather meagre consisting of *Desmodium triquetrum, Blepharis asperrima, Eranthemum roseum* and *Colebrookia oppositifolia*. A few orchids grow on trees such as *Aerides crispum* and *Dendrobium barbatulum, Eria dalzelli, Oberonia* sps. and also *Hoya wightii.* Of these

Terminalia crenulata, *Dillenia indica Thespesia lampas* and Orchids suggest moist deciduous type of vegetation, whereas *Bridelia squamosa*, *Gmelina arborea*. *Dalbergia sympathetica*, *Jasminum malabaricum*, *Memycelon umbellatum*, *Colebrookia oppositifolia* suggest dry and semi-evergreen type of vegetation. At the foot of the hill the vegetation becomes sparse and is typical of dry hills. Here one notices *Grewia tilaefolia*, *Reinwardtia trigyna*, and *Lasiosiphon eriocephalus*. They suggest mixed vegetation. *Sterculia guttata*, *Bombax insigne* on the hill opposite Chita-Darwaja suggest dry vegetation, as in drier areas of Lonavala and Khandala in seasons other than rainy season.

A little higher from the base of the hill one gets *Carvia callosa*, *Glochidion hohenackeri*, *Erinocarpus* sp, *Mappia foetida*, *Mallotus philipinesis*, *Barleria prionitis*, *Ficus hispida*, *Callicarpa lanata*, *Strobilanthus* sps, *Abutilon polyandrum*. They are also common in the upper part of the hill as they are elsewhere in Sahyadri ranges. Within the enclosure of the hill fort *Vitex negundo*, *Mallotus philippinesis*, *Pimpinella* sps. occur in dry habitats. They are usually associated with *Lobelia nicotinifolia*, *Terniola zeylanica*, grown on moist soil.

At present attempts are being made to plant a number of trees of *Casuarina equisetifolia*, *Peltophorum feruginosum*, *Delonix regia*, *Semicarpus indica*, *Dalbergia latifolia*. They all grow pretty well. A detailed list of plants on Raigad is given below from which it becomes clear that the flora is neither entirely dry or moist deciduous nor semi-evergreen, but a mixture of the two. Apparently the vegetation must have been altered much later, but must be richer in the past as humidity throughout the year is quite high. The species in the villages here and on the Sahyadri plateaus are a mixture of species common on the Konkan plain and on the slopes and semi-dry coastal forests of Malabar, but their density is not as great as that in Goa, north Kanara or Malabar.

List of the Plants of "aigad Fort (*after Vartak*, 1966)

(Names given in brackets are Marathi)

Ranunculaceae
Clematis gouriana Roxb. (Morvel).

Delleniaceae
Dillenia pentagyna Roxb. (Karmal)

Annonaceae
Sageraea laurina D. and G. (Sayeri)

Menispermaceas
Tinospora cordifolia Miers, (Gulvel)
Cocculus hirsutus Diels. (Vasanvel)
Stephania japonica Miers.
Cyclea burmanni Miers (Pahadvel)
Diplocilisia glancescens Diels. (Vatoli)

Capparidaceae
Capparis spinosa L. (Kabar)
Capparis pedunculosa Wall. (Kolishna)

Flacourtiaceae
Flacourtia latifolia Cooke (Tambat)

Portulacaceae
Portulaca oleracea L. (Gholu)

Malvaceae
Sida veronicifolia Lam.
Sida rhombifolia L. var. *retusa* Masters (Chikana)
Abutilon polyandrum W. and A.
Urena lobata L.
Hibisus hirtus L.
Hibisus tetraphyllus Roxb. (Ranbhendi)
Hibisus rosa-sinensis L. (Jaswand)
Thespesia populnea Soland.
Thespesia lampas Dalz.

Bombacaceae
Bombax cieba L.
Bombax insignis wall.

Sterculiaceae
Sterculia guttata Roxb. (Goldar)
Helicteris isora L. (Murudsheng)

Tiliaceae
Grewia tiliaefolia Vahl.
Grewia abutiltfolia Vent.
Erinocarpus nimmonii Graham
Triumfetta rhomboidea Jacq.
Corchorus capsularis L.

Linaceae
Reinwardtia trigyna Planch.

Oxalidaceas
Oxalis corniculata L.

Balsaminaceae
Impatiens balsamina L.

Rutaceae
Fagara budrunga Roxb.
Murraya koenigii Spreng.
Atlantia racemosa W. and A.

Meliaceae
Melia composita Willd.
Heynea trijuga Roxb.

Hippocrateaceae
Pristimera grahami A. C. Smith

Celastraceas
Celastrus paniculata Willd
Gymnosporia rothiana Laws

Rhamnaceae
Zizyphus jujuba Lamk.
Zizyphus rugosa Lamk.
Zizyphus oenoplia Mill.

Ampelidaceae
Cissus elongata Roxb
Cissus latifolia Vahl
Cissus repanda Vahl.
Leea indica Merrill

Sapindaceae
Allophyllus serratus Radlk.

Anacardiaceae
Mangifera indica L.
Anacardium occidentale L.
Lannea coromandelica Merrill
Semicarpus anacardium L.

Papilionaceae
Crotalaria fillipes Benth.
Crotalaria prosstrata Roxb.
Crotalaria bifaria L.
Crotalaria retusa L.
Indigofera linifolia Retz
Indigofera pulchella Roxb.
Geissaspis cristata W. and A.
Smithia purpurea Hook.
Smithia conferta Sm.
Alysicarpus vaginalis DC.
Alysicarpus sp.
Desmodium triflorum DC.
Desmodium triguetrum
Teramnus labialis Spreng
Mucuna prurita Hook.
Erythrina variegata L.
Butea monosperma D. Kuntze
Atylosia lineata W. and A.
Cylista scariosa Roxb.
Moghania strobilifera St. Hil.
Dalbergia latifolia Roxb
Dalbergia sympathetica Nimmo
Pongamia pinnata Pierre

Caesalpiniaceae
Delonix regia Raf.
Wagatea spicata Dalz.
Cassia fistula L.
Cassia tora L.
Peltophonum inerme Naves.
Bauhinia racemosa Lamk.
Tamarindus indica L.

Mimosaceae
Acacia chundra Willd.
Acacia concinna DC.
Acacia intsia Willd.
Albizzia odoratissima Benth.
Albizzia procera Benth.

Crassulaceae
Bryophllum pinnatum Oken

Combretaceae
Terminalia arjuna W. and A.
Terminalia crenulata Roth
Terminalia paniculata Roth.
Calycopteris floribunda Lamk.
Anogeissus latifolia Wall
Combretum ovalifolium Roxb.

Myrtaceae
Syzygium cumini Skoels
Syzygium jambos Alston

Melastomaceae
Osbeckia truncata Don
Memecylon umbellatum Burm.

Lythraceae
Rotala tenuis Kashna
Rotala indica Koshna
Woodfordia fruticosa Kurr
Lawsonia inermis L.
Lagerstroemia parviflora Roxb.
Lagerstroemia lanceolata Wall.

Samydaceae
Casearia graveolens Dalz.

Cucurbitaceae
Trichosanthes bracteata Voigt
Trichosanthes cucumerina L.
Cucumis melo var. *agrests* Nand
Melothria heterophylla Cogn.
Cucurbita maxima Duch.

Umbellifarae
Trachispermum stictocarpum Wolff
Pimpinella adscandens Dalz.
Centella asiatica Brphn.

Rubiaceae
Mitragyna parvifolia Korth.
Oldenlandia coymbosa L.
Anotis lanclfolia Hook.
Randia brandisil Gamble
Canthium dicoccum Merril
Meyna laxiflora Robyn
Ixora arborea Roxb.
Ixora nigricans R. Br.
Pavetta indica L.
Hamiltonia suaveolens Roxb.

Compositae
Centratherum phyllolaenum Benth
Vernonia cinerea L.
Ageratum conyzoides L.
Cyathocline purpurea Kunth
Conyza stricta Willd.
Blumea oxydonta DC.

Blumea malcolmii Hook.
Blumea membranacea DC.
Sphaeranthus indicus L.
Gnaphalium indicum L.
Vicoa cernua Dalz.
Caesulia axillaris Roxb.
Eclipta alba L.
Erigeron asteroides Roxb.
Tridax procumbens L.
Artemisia parviflora Buch-Ham
Senecio grahmami Hook
Tricholepis glaberrima DC.
Acanthosperumum hispidum DC.

Lobeliaceae
Lobelia nicotianifolia Heyne
Lobelia alsinoides Lamk.

Plumbaginaceae
Plumbago zeylanica L.

Myrsinaceae
Embelia tsjeriam-cottam A. DC.

Sapotaceae
Pouteria tomentosa Baeclni

Oleaceae
Jasminum malabariculm L.
Jasminum grandiflorum L.

Apocynaceae
Carissa congesta Wight
Holarrhena antidysenterica Wall
Wrightia tinctoria R. Br.
Plumeria acuminata Ait.
Tabernaemontana divariegata R. Br.

Asclepiadaceae
Hemidesmus indicus R. Br.
Cryptolepis buchanani Room.
Calotropis gigantea R. Br.
Tylophora Sp.
Hoya wighti Hook.

Gentianaceae
Centeurium roxburghii Druce:
Canscora diffusa R. Br.

Boraginaceae
Cordia dichotoma Forst
Cordia macleodii Hook.
Cynoglossum glochidiatum Wall.
Adelocaryum coelestinum Brand.

Convolvulaceae
Porana malabarica C. B. C.
Ipomoea nil Roth

Solanacae
Solanum indicum L.
Solanum nigrum L.
Physalis minima L.
Nicotiana tabacum L.

Scrophulariaceae
Verbascum coromandelianum Kuntz.
Striga gesneroides Vatke.
Lindenbergia urticifolia Link.

Bignoniaceae
Oroxylum indicum Vent.
Heterophragma quadriloculare K. Schem.

Acanthaceae
Blepharis asperrima Nees
Hygrophila serpyllum T. Anders
Hemigraphis latebrosa Nees
Eranthemum roseum R. Br.
Pleocaulus ritchiei Bremek.
Carvia callosa Bremck.
Thelepaepale ixiocephale Bremek.
Strobilanthus sp.
Haolanthus vagrticillatus Nees.
Barleria prionitis L.
Barleria cuspidata Heyne
Barleria lawii T. Anders
Neuracanthus sphaerostechyus Dalz.
Asystasia qanqetica T. Anders
Runqia pectinata Nees
Dicliptera zeylanica Nees
Justicia simplex D. Don
Justicia betonica L.
Adhatoda vasica Nees
Rhinacanthus hirsuta kurtr

Verbenaceae
Lantana camara L.
Callicarpa tomentosa Murray
Tectona qrandis L.
Gmelina arborea Roxb.
Vitex negundo L.

Labiatae
Ocimum sactum L.
Pogostemon plactranthoides Desf.
Dysophylla stellata Benth.
Colebrookea oppositifolia Smith
Anisomeles heyneana Benth.
Leucas stelligera wall.
Leucas montana Spreng.
Leucas ciliata Benth.

Amaranthaceae
Aerva sanguinolenta Blume
Achyranthus aspera L.
Alternanthera sessilis R. Br.
Amaranthus hybridus L.

Podostemaceae
Terniola zeylanica Tul.

Polygonaceae
Polygonum plebejum R. Br.
Polygonum glabrum Willd.

Loranthaceae
Dendrophthoe falcata Etting. E.
Taxillus cuneatus Danser

Euphorbiaceae
Euphorbia hirta L.
Euphorbia elegans Spreng
Bridelia squamosa Gehrum
Glochidion hohenackeri Bedd.
Melanthesa turbinata Wight
Cicca acida Merrill
Mallotus philippinesis Lamk.
Tragia mulleriana Pay

Ulncaceae
Holoptelea integrifolia Planch

Urticaceae
Girardiana zeylanica Deiane
Boehmeria scabrella Gand

Moraceae
Ficus bengalensis L.
Ficus rumphii Blume
Ficus religiosa L.
Ficus arnottiana Mig.
Ficus hispida L.
Ficus glomerata Roxb.
Artocarpus integra Merrill

Casuarinaceae
Casuarina equisetifolia L.

Orchidaceae
Oberonia recurva Lindl,
Dendrobium barbatulum Lindl
Dendrobium sp.
Eria dalzellii Lindl.
Aerides sp. (eriopum ?)

Dioscoreaceae
Dioscorea pentaphylla L.
Dioscorea bulbifera L.
Dioscorea oppositifolia L.

Agavaceae:
Agave cantala Roxb.

Liliaceae
Asparagus racemosus Willd.

Smilaceae
Smilax zeylanica L.

Cyperaceae
Cyperus iria L.
Cyperus malabaricus Clarke
Cyperus natans Vahl,
Cyperus pumilus L.
Fimbristylis dichotoma Vahl.

11. Flora of Ratnagiri and Sindhudurg Districts :

Ratnagiri being a very large district, it was customary to speak of it as made up of two parts, North and South Ratnagiri. They are now actually formed into two districts : Southern part is called Sindhudurg and Northern part as Ratnagiri district. The flora of South Ratnagiri (Sindhudurg) including Sawantwadi is very rich and contains many plants that are common to North Kanara, Malabar, and a few to the hilly regions of high altitude on Desh side. The flora of North Konkan or Ratnagiri on the other hand, contains several species which are common to Bombay, Thane, South Gujarat, the Dangs and Panch Mahal. It is not so rich in plants like Sindhudurg district, as the rainfall becomes less as one goes northwards. The flora of South Ratnagiri is better known due to efforts of early botanists like Dalzell, Gibson, Talbot, Dalgado and especially Nairne. All these botanists had first-hand knowledge of South Konkan plants as they actually lived there and collected plants. Nairne (1894) was living in Vengurla as an officer in the Ecclesiastic Service of the Bombay Government. As such there are numerous references to local plants of South Konkan in his "Flowering Plants of Western India". Cooke (1903-1908) included in his work many species of both North and South Konkan not on his collections, but solely the collections of others, made by the early botanists. His account, therefore, lacks specific mention of localities and he often describes distribution as "common in Konkan Hills", "Konkan Jungles", "North and South Konkan" etc. This is unhelpful to the collectors who want to collect and study distribution of a particular species. In his *Flora of the Bombay Presidency* there are references to Konkan flora comprising 1038 dicotyledonous plants and 337 monocots. But when one examines the plants he has mentioned from a few localities such as Ratnagiri, Mirya Dongar, Mandangad, Chiplun, Pen, Dapoli, Dasgaon, Shrivardhan, Varasgaon, Alibag, and Kalyan, one is disappointed to note that the plants he mentioned with localities in North Konkan are from well known places and are mostly herbaceous such as *Crotolaria albida*, *Indigofera tinctoria*, *Smithia setulosa*, *Blumea oxydonta*, *Ipomoea lawii* *Pedalium murex*, *Dadelacanthus rosea*, *Lepidagathis cristata*, *Rungia parviflora*, *Euphorbia microphylla*, *Zingiber macrostachys*, *Panicum myosuroides*, *Aurundinella avenacea*, and a few shrubs like *Casearia graviolens*, *Clerodendron serratum*. Trees and creepers one finds still less. *Anthoceplalus indicus*, *Cassia grande*, *C.absus*, *Ixora nigricans* etc. On the other hand references to herbs, trees and shrubs from South Konkan are many. That only shows how poor were the collections made in North Ratnagiri.

Nairne's (1894) flora on the other hand mentions several other plants like *Unona discolor*, *Ventilago latifolia*, *Uraria fistula*, *Carallia integerima*, *Calycoteris floribunda*, *Oimanthus urecelatus*. There is no doubt about them because Nairne had collected intensively during his long stay at Vengurla. Many plants of South Ratnagiri or Sindhudurg represent moist types and some evergreen species e.g. *Litsea*, *Mesua* *Dipterocarpus* which are not to be found in North Konkan. Represen-

tative flora of Ratnagiri district would be similar to those found in the Bombay Island, Salsette, Thane hills and valleys around Bombay.

Recently the flora of Sindhudurg district has been fully worked out by Dr. B.G.Kulkarni of the Botanical Survey of India, Pune, and the list of plants given here is mainly on the basis of his work. Although now North and South Ratnagiri are politically two districts, botanically they are the parts of the same sub-province and therefore their plants are dealt with together here.

Flora of South Konkan, abounds in places with moist or humid species forming semi-evergreen vegetation and a few pockets of evergreen vegetation in the depressions and ghats. Both the districts have continuous ranges of Sahyadris with straight drop at places on the west ; for example in Amboli ghat at a village called Tambechi Wadi, at a village Palgaon there is a straight drop of rock 1000′ to 1500′ forming a huge escarpment. This gives heavy rainfall in the areas adjacent to Sahyadris, but not so in the areas near coast. The parts of Konkan, therefore, at the foot of the Sahyadris are marshy. Where the soil is accumulated there is good forest. Where there is no soil, it is very poor in *Varkas* soil. At the west margin of Konkan, Sahyadri ranges end abruptly, from crest to sea coast. There is plain. The principal species of the two districts are given together. The flora of Kankavali is known better and is given separately.

The whole Konkan is traversed by a number of small rivers from Alibag, Chiplun to Sawantwadi and Terekhol. They form rich mangrove vegetation on their bank in a number of places, and in semi-marine conditions at other places.

At the coast also there are mangroves in mud flats and a belt of strand plants behind them in sandy or clayey areas. A number of sand binders grow in the sands behind the mud flat. A large number of medicinal plants are known from Sindhudurg district. The two districts are quite suitable for cultivation of plantation crops, palms and fruit trees especially at Dapoli, Deogad, Ratnagiri and Sawantwadi. However soil being poor only minor millets are grown as crops in Konkan.

The flora of Goa and Sindhudurg district was studied by Dalgado (1896) with reference to Sawantwadi. It contains some pockets of evergreen vegetation. A number of medicinal plants and some newly introduced plants such as cashew and good mango varieties are grown. Cocoa (*Theobroma cocoa*) grows well in Sawantwadi. It has a great potential for plant introduction of Rubber, Spices, Jute etc. started earlier by Dalgado (1896). He was serving as Civil Surgeon of Sawantwadi State. The Ratnagiri and Raigad districts have hot water springs. Their flora is unworked. Mangroves and strand plants flora and vegetation of Kankavali are better known. The ghat flora of Amboli, Amba, and Phonda deserve special attention for research.

Sawantwadi and its plants and flora

It is very rich in flora being, contiguous with Goa , North Kanara, Kolhapur and Malabar. Its plants are mentioned here mainly with the help of the work of Dr. B. G. Kulkarni (1979) who has made a special study of South Ratnagiri. The important plants in its flora are intended in the common list.

11·1. Plants of Ratnagiri and Sindhudurg

Name	Fl. Season	Locality
Ranunculaceae		
Clematis gouriana Roxb. ..	Oct.-Nov. ..	Phonda ghat, Amboli ghat
C hedysarifolia DC. ..	Oct.-Nov. ..	Kankavali, Kudal
Naravelia zeylanica DC. ..	Oct.—Dec. ..	S. M. country only in the ghats
Dilleniaceae		
Dillenia indica Linn. ..	June	Alibag, Sawantwadi, South Konkan
D. pentagyna Roxb. ..	Mar.-Apr. ..	Sawantwadi, on Western face of ghats, Matheran
Magnoliaceae		
Michelia champaca Linn. ..	Apr.—Sept. ..	Cultivated
Anonaceae		
Meiogyne pannosa (Dalz.) Sincl.	..	Amboli, Kankavali
Sageraea laurifolia (Grdhi) Blatt.	..	Kankavali, Ramghat
Uvaria narum (Dunal) Blume	Nov.	Kankavali, Amboli, Phonda
Anona squamosa Linn ..	May—July ..	Cultivated
Menispermaceae		
Tinospora cordifolia (Willd) Miers	Apr.	Deogad, Konkan common
T. sinensis (Lour) Merr. ..	..	Vengurla
Anamirta cocculus (Linn.) W and A.	..	Kankavli, Phonda, Konkan common
Cocculus hirsutus (Linn) Diels	..	Phonda, Kankavali, Kudal
Diploclisia glauceascens (Bl.) Diels	..	Kankavali, Amboli, Kudal
Stephania japonica (Thumb.) Miers	..	Amboli
Cissampelos pareira, Linn. ..	..	Malwan, Deogad, Kankavali
Nymphaeaceae		
Nymphaea pubescens Willd ..	..	Kudal
N. nouchali Burm f. ..	..	Malvan

Name	Fl. Season	Locality
Papaveraceae		
Argemone mexicana Linn. ..	All the year ..	Kankavali, Kudal, (Introduced as weed)
Brassicaceae		
Brassica juncea (Linn) Czern.	..	Bhedshi, cultivated
Cardamine trichocarpa Hochst ex Rich.	..	High hills of Konkan, Amboli
Raphanus aestivus Linn. ..	..	Malvan, cultivated
Capparidaceae		
Cleome viscosa Linn. ..	Sept.—June ..	Guest House at Vengurla, Kudal, Bhedshi
C. chelidonii Linn. f. ..	July—Feb. ..	Ramghat, moist places
C. speciosa Ref. ..	..	Kankavali
Crataeva nurvala Buch-Ham	..	Malvan.
Crataeva nurvala Buch-Ham var. *C. religiosa* Mart.	..	Bhedshi, Sawantwadi.
Capparis rotundifolia Rottl.	..	Amboli, Deogad, Malvan.
C. zeylanica Linn. ..	Feb.—Apr. ..	Deogad, Malvan, Akeri, Vengurla
C. moonii wt. ..	.. Jan. ..	.. Amboli ghat, Bhedshi
Violaceae		
Hybanthus, enneaspermus (L) Muell.		
Hybanthus, suffruticosus (Linn) Baill ex Lan.		
Bixaceae		
Bixa orellana Linn ..	Aug.-Sept. ..	Kudal, Introduced
Flacourtiaceae		
Hydnocarpus laurifolia (Dennst) Sleum.	..	Kankavali, Kudal, Amboli ghat
Homalium, zeylanicum Benth.	..	Amboli ghat
Flacourtia, montana Grah. ..	Nov.-Dec. ..	Kankavali, Kudal, Bhedshi
F. indica (Burm. f.) Merr. ..	..	Deogad, Kudal hills of Konkan Malvan
Casearia graveolens Dalz.	..	Kankavali, Malvan, Kudal, Vengurla
C. esculenta Roxb.	..	Kankavali, Bhedshi
C. rubescens Dalz. ..	..	Kankavali, Kudal

Name	Fl. Season	Locality
Pittosporaceae		
Pittosporum nepdulense (DC.) Rehd and Wilson.	..	Amboli ghat
Polygalaceae		
Polygala elongata Klein ex Willd.	Aug.—Nov. ..	Malvan, Sawantwadi, Deogad, Kankavali, Kudal
Salomonia ciliata (Linn.) DC.	..	Malvan
Caryophyllaceae		
Polycarpon prostratum (Forsk.) Asch. and Schw.	..	Vengurla, Kudal
Polycarpea corymbosa (Linn.) Lamk.	Oct.—Jan. ..	Malvan, common in vicinity.
Portulacaceae		
Portulaca oleracea Linn. ..	Oct.—Dec. ..	Deogad, Akeri as weed in cultivated.
Tamaricaceae		
Tamarix ericoides Rottl. ..	Nov.—Jan. ..	Kankavali
Elatinaceae		
Bergia ammannioides Roxb. ex Roth.	Nov.-Dec. ..	Abyssinian plant on margins of tank
Guttiferae :		
Garcinia indica (Dupetit-Thou.) Choisy.	Nov.—Feb. ..	Kudal, Sawantwadi, Vengurla.
G. talbotii Raiz. ex Sant.	..	Kankavali, Sawantwadi.
Mammea suriga (Buch. Ham ex Roxb) Kosterm.	..	Kankavali, Kudal
Calophyllum inophyllum Linn.	Dec.-Jan. ..	Deogad, Sawantwadi.
C. apetalum Willd. ..	..	Sawantwadi
Mesua ferrea Linn.	March ..	Kudal, Bhedshi, forests of Sawantwadi.
Ancistrocladaceae :		
Ancistrocladus heyneanus Wall ex Grah.	..	Kankavali, Bhedshi, Matheran, Thane, ghats.
Malvaceae :		
Sida cordata (Burm. f.) Bross.	Oct.—Jan. ..	Deogad, Sawantwadi., Malvan.
Sida rhombifolia Linn. ..	Oct.—Dec. ..	Kankavali, Bhedshi-(weed).
S. cordifolia Linn.	Oct.-Nov. ..	Malwan
Abutilon persicum (Burm. f.) Merr.	..	Kudal, Bhedshi
Abutilon indicum (Linn.) SW	All the year ..	Deogad, common in S. Matheran.

Name	Fl. Season	Locality
Urena lobata Linn.	Oct.—Dec. ..	Kudal, Bhedshi, Kalyan.
Decaschistia trilobata Wt. ..	Oct.-Nov. ..	Amboli, Kankavali, Kudal, Bhedshi.
Hibiscus furcatus Roxb. ..	Dec.—Feb. ..	Kankavali, Sawantwadi.
H. hirtus Linn. Var. *talbotii* Rakshit.	Oct.—Jan. ..	Lower ghats below Matheran, Phonda.
H. witifolius Linn	Oct.—Dec. ..	Revdanda, Matheran, Malvan.
H. cannabinus Linn.	January ..	Ghats, Kankavali
H. rosa sinensis Linn. ..	All the year ..	Cultivated
Abelomoschus manihot ..	..	Kudal, Bhedshi
Ssp. *tetraphyllus* (Roxb. ex. Horn) Bross.	..	Sawantwadi country
Sterculiaceae :		
Peterospermum acerifolium willd.	Dec.—Mar. ..	Cultivated
Melochia corchorifolia Linn.	Sept.—Nov. ..	Deogad, Kudal
Waltheria indica Linn. ..	Aug.-Sept. ..	Konkan, Vasai, Deogad, Malvan.
Tiliaceae :		
Grewia umbellata Roxb. ..	..	Konkan, Kankavali, Sawantwadi.
G. tilaeifolia Vahl. ..	May—Aug. ..	Elephanta, Salsette
Var. *leptopetala* Cooke ..	..	Deogad, Bhedshi
G. serrulata DC.	..	Kankavali, Bhedshi
G. pilosa Lamk.	Aug.—Oct. ..	Kankavali, Bhedshi
G. abutilifolia Vent. ex Juss.	June	Deogad, Sawantwadi.
Microcos paniculata Linn. ..	..	Sawantwadi, Kankavil hills.
Erinocarpus nimmonii Grah. ex Dalz and Gibs.	Aug.-Sept. ..	Kankavali, Sawantwadi
Triumfetta rhomboidea Jacq.	Sept.—Dec. ..	Deogad, Bhedshi
Corchorus capsularis Linn. ..	September ..	Kankavali, Sawantwadi.
C. aestuans Linn.	..	Deogad, Sawantwadi.
C. olltorius Linn.	September ..	Deogad
Elaeocarpaceae :		
Elaeocarpus serratus Linn. ..	Jan.-Feb. ..	Bhedshi
Linaceae :		
Linum mysorense Heyne ex Benth. apud, Lindl.	Oct.—Dec. ..	Kankavali, Sawantwadi hills.
Reinwardtia indica Dumort.	..	Sawantwadi
Malpighiaceae :		
Hiptage benghalensis (Linn.) Kurz.	..	Kankavali, Sawantwadi, ghat jungles, also cultivated.
Aspidopteris cordata (Heyne) Juss.	Sept.—Nov. ..	Kankavali, Sawantwadi, Salsette island.

Name	Fl. Season	Locality
Oxalidaceae :		
Oxalis cornicuulata Linn.	Oct.—May	Sawantwadi
Bioplıytum candolleanum Wt.		Kankavali, Sawantwadi.
Balsaminaceae :		
Impatiens acaulis Arn.		Kankavali, Sawantwadi, Matheran.
I. kleinii W. and A		Mirya dongar, Kankavali, Bhedshi.
I. pusilla Heyne ex Hook. f. and Th.	Aug.—Oct.	Sawantwadi
I. lawii Hook f. and Th.	October	S. Konkan, Sawantwadi.
I. balsamina Linn.		Konkan ghat, Deogad Sawantwadi.
I. pulcherrima Dalz.	Sep.-Oct.	Fitzgerald ghat
Rutaceae :		
Evodia lunu-ankenda (Gaertn.) Merr.		Sawantwadi
Zanthoxylum rhetsa (Roxb) DC.		
Zanthoxylum limonella (Dennst.) Alston.		Vengurla, Kankavali, Sawantwadi.
Toddalia asiatica (Linn.) Lamk.		Sawantwadi
Acronychia pedunculata (Linn.) Miq.		Sawantwadi
Glycosmis mauritiana (Lamk.) Tanaka.		Moist evergreen Konkan forest, Sawantwadi.
Murraya paniculata (Linn.) Jack.		Kankavali, Bhedshi, Matheran.
M. koenigii (Linn.) Spreng.	Feb.—Apr.	Kudal, Sawantwadi, ghats.
Clausena dentata (Will) Roem.		Sawantwadi, Borivli forest.
Lavanga sarmentosa (Bl.) Kurz.		Sawantwadi
Paramignya monopnhylla Wt.	Nov.—Jan.	Konkan, Bhedshi, Amboli ghat.
Atalantia racemosa W and A.	Nov.-Dec.	S. Konkan, Amboli ghat.
Ochnaceae :		
Ochna obtusata DC.		Kankavali, Bhedshi
Burseraceae :		
Garuga pinnata Roxb.	Feb.-Mar.	Kankavali, Bhedshi Konkan, hills of Matheran.
Meliaceae :		
Naregamia alata W. and A.	Aug.—Oct.	Malwan, Bhedshi, Panvel, Vengurla.
Turrea villosa Benn.	Apr.—June	S. Konkan, Kankavali, Sawantwadi.
Aglaia elaeagnioides (Juss.) Benth.		

Name	Fl. Season	Locality
Amoora lawii Bedd.	Dec.-Jan. ..	Kankavali, Bhedshi, hills of Nagothana, Amboli ghat.
Walsura trifoliata (A. Juss.) Harms.	..	Sawantwadi.
Dysoxylum binectariferum (Roxb.) Hook f. ex Bedd.	Aug.-Sept. ..	Kankavali, Bhedshi, Phonda ghat.
Trichilia connaroides (Wt and Arn) Bent.	Sept.-Oct. ..	Kankavali
Chukrassia tabularis Juss. var. *velutina* King.	Feb.—Apr. ..	Matheran, Kankavali, Bhedshi, Tungar hills.
Toona ciliata Roem. ..	May ..	Matheran hills, Kudal, Bhedshi.
Dichapetalaceae :		
Dichapetalum gelonioides (Roxb.) Engl.	Mar.-Apr. ..	Sawantwadi.
Olacaceae :		
Olax wightiana wall. ex W. and A.	Dec.—Feb. ..	Kudal, Bhedshi, High hills of Konkan.
Opiliaceae :		
Cansjera rheedii Gmel. ..	..	Elephanta, Malvan, Sawantwadi, Salsette island.
Icacinaceae :		
Nothopodytes foetida (Wt.) *Sleum.*	Mar.—May ..	Kankavali, Sawantwadi.
Celastraceae :		
Lophopetalum wightianum Arn.	Mar.—May ..	Kankavali, evergreen forest of Konkan
Euonymus indicus Heyne ex Wall.	..	Sawantwadi.
Meytenus rothiana (Walp.) Ramm.	..	Konkan, Bhedshi, Sawantwadi.
Cassine glauca (Rottb) *O.* Ktze.		
Celastrus paniculata (Wt. and Arn.) Lob.	Nov.—Feb. ..	Konkan, Bhedshi, low jungles in hilly parts.
Hippocratea, grahamii Wt. ..	Jan.—Apr. ..	Bhedshi, Matheran, moist ghat forests of Thane.
H. indica Willd.	Apr. ..	Kudal, Bhedshi, moist forest along the ghats.
Salacia chinensis Linn.		
S. macrosperma Wt. ..	Jan. ..	Kankavali, Konkan, Amboli ghat
Rhamnaceae :		
Scutia circumscissa (Linn. f.) Druce.	..	Kudal, Bhedshi, Phonda.
Ventilago, maderaspatana Gaertn.	Dec-Jan. ..	Kankavali, Matheran.

Name		Fl. Season		Locality
V. bombaiensis Dalz.	..	Mar.-Apr.	..	Sawantwadi.
Colubrina, asiatica (Linn.) Brongn.		Feb.	..	Deogad, Elephanta, Kudal, Bhedshi.
Zizyphus, xylopyrus Willd.		May—July	..	Deogad, Bhedshi, ravines of Matheran.
Z. oenoplia (Linn.) Mill.		Aug.-Sept.	..	Ghats
Z. rugosa Lamk.	..	Dec.—Feb.	..	Konkan, Deogad, Sawantwadi.
Vitaceae :				
Ampelocissus latifolius (Roxb.) Planch.		June—Aug.	..	Hills of Ratnagiri.
Cissus discolor Bl.	..	Aug.-Sept.	..	Kankavali, Bhedshi.
C. repens Lamk.	..	Feb.-Mar.	..	Kudal, Bhedshi.
C. repanda Vahl.	..	Apr.—June	..	Kudal, Sawantwadi.
C. adnata Roxb.	..	Nov.—Feb.	..	Kankavali, Kudal.
Tetrastigma canarense (Dalz.) Gamble.		Feb.-Mar.	..	Sawantwadi.
Cayratia trifolia (Linn.) Domin.		May-June	..	Kudal, Sawantwadi
C. elongata (Roxb.) Suess		July-Aug.	..	Deogad, Bhedshi.
Leeaceae :				
Leea macrophylla Roxb. ex Hornem		July—Sept.	..	Ghat jungles, Matheran, Malvan.
L. crispa Linn.	.. ..	Aug.	..	Moist forest Kudal, Sawantwadi.
L. edgeworthii Sant.	..	July-Aug.	..	Deogad, Sawantwadi
L. indica (Burm, f.) Merr.	..	Feb.—Oct.	..	Kankavali, Bhedshi.
L. robusta Roxb.	..	Aug.	..	Mirya Dongar, Pen, Sawantwadi.
Sapindaceae :				
Cardiospermum helicacabum Linn.		Dec.	..	Malvan.
Allyophylus cobbe (Linn.) Raeusch.		May—Aug.	..	Mirya Dongar Vengurla, Bhedshi.
Schleichera oleosa (Lour.) Oken.		Mar.-Apr.	..	Kankavali, Sawantwadi, Matheran.
Dimocarpus longan Lour.		Feb-Mar.	..	Kankavali, Bhedshi, Salsette island.
Sapindus laurifolius Vehl	..	Oct.—Dec.	..	Sawantwadi.
Lepisanthes tetraphylla (Vahl) Radik.		Feb.—Apr.	..	Kankavali, Bhedshi.
Anacardiaceae :				
Holigarna arnottiana (W. and A.) Hook-f.		Jan.-Feb.	..	Kudal, Sawantwadi.
H. grahamii (Wt.) Kurz	..	May-June	..	Bhedshi, in evergreen forest.
Buchanania lanzan Spreng.		Jan.—Mar.	..	Kudal, Bhedshi, Sawantwadi.

Name	Fl. Season	Locality
Mangifera indica Linn.	Jan.-Feb.	Mostly cultivated.
Nothopegia dalzellii Gamble	Jan.—Mar.	Konkan, Bhedshi.
Semecarpus anacardium Linn. f.	May-July	Malvan, Bhedshi.
Spondias pinnata (Linn. f.) Kurz.	Feb.	Kudal, Bhedshi, Malvan.
Lannea coromandelica (Houtt) Merr.	Feb.-Mar.	Deogad, Bhedshi.
Anacardium occidentale Linn.	Jan.—Mar.	Kankavali, Sawantwadi, Vengurla.
Connaraceae :		
Rourea praineana Talb.	Sept.—Nov.	Sawantwadi, Mirya dongar
Connarus wightii Hook. f.	Feb.	Kankavali, Amboli ghat
C. ritchiei Hook. f.	Apr.	Sawantwadi, Bhedshi.
Fabaceae :		
Erythrina orientalis Linn.	Feb.—Apr.	Kankavali, Bhedshi, Matheran.
Butea monosperma (Lamk.) Taub.	Feb.-Mar.	Konkan.
Derris indica (Lamk.) Ben.	Feb.—Apr.	Kankavali, Kudal.
Pongamia pinnata (Linn.) Pierre.		
Dalbergia latifolia Roxb.	..	Kankavali, Bhedshi, Vengurla.
D. paniculata Roxb.	Apr.-May	Matheran ghat, Deogad.
D. sympathetica Nimmo ex Grah.	..	Kudal, Bhedshi, Matheran.
D. volubilis Roxb.	Feb.-Mar.	Bhedshi, Nagothana, Kankavali.
Pterocarpus marsupium Roxb.	May-June	Kankavali, Nagothana hills.
Mucuna monosperma DC.	..	Kudal, Bhedshi.
M. prurita Hook.	Aug.—Dec.	Sawantwadi, Vasai.
Canavalia virosa (Roxb.) Wt. and Arn.	..	Malvan.
C. rosea (SW.) DC.	..	Malwan, Vengurla.
Cylista scariosa Roxb.	Nov.—Feb.	Kudal, Bhedshi, Matheran.
Abrus precatorius Linn.	Sept.—Oct.	Kankavali, Vengurla.
Derris trifoliata Lour.	..	Deogad, Malwan.
D. scandens (Roxb.) Benth.	June—Aug.	Kudal, Bhedshi.
D. canarensis (Dalz) Bak.		
D. heyneana Benth.		
Goniogyna hirta (Willd.) Ali.	..	Kankavali, Sawantwadi.
Crotolaria filipes Benth.	Oct—Dec.	Salsette island.
C. albida Heyne ex Roth.	Dec—Feb.	Kankavali, Kudal.
C. linifolia Linn. f.	Sept.	Konkan, Malwan, Bhedshi
C. lutescens Dalz.	Aug—Oct.	Vengurla, Malwan.

Name		Fl. Season		Locality
C. nana Burm. f.	..	Sept.-Oct.	..	Vengurla, Malwan.
C. prostrata Rottl. ex Willd.		Oct.-Nov.	..	Kankavali, Sawantwadi.
C. vestita Baker	..	..		Deogad, Bhedshi.
C. retusa Linn. ..	..	Sept.—Nov.	..	Konkan plains.
C. mysorensis Roth	..	Oct.	..	Kankavali, Deogad, Sawantwadi.
C. verrucosa Linn.	..	Oct.-Nov.	..	Kankavali, Vengurla, Bhedshi.
C. triquetra Dalz.	..	Oct.	..	Malvan, Vengurla, Sawantwadi.
C. mucronata Desv.	..	..		South Konkan.
Alysicarpus vaginalis (Linn.) DC.		Oct.	..	Sawantwadi, Deogad, Konkan.
A. procumbens (Roxb.) Schindl.		..		Malwan.
A. bupleurifolius (Linn.) DC.		June—Sept.	..	Kankavali, Sawantwadi, Vengurla.
A. longifolius Wt. and Arn.		Sept.	..	Malwan.
A. rugosus (Willd.) DC.	..	..		Malwan.
A. belgaumensis wt. ..	..	Sept.-Oct.	..	Kankavali, Bhedshi.
Desmodium triquetrum (Linn.) DC.		Sept.—Dec.	..	Kudal, Malabar hill, Bhedshi.
D. gangeticum (Linn.) DC.		May—July	..	Kudal, Salsette, Vengurla.
D. pulchellum (Linn.) Benth.		Aug—Oct.	..	Sawantwadi
D. heterocarpon (Linn.) DC.		..		Kankavali, Sawantwadi, Matheran hills
Desmodium laxiflorum DC.		Aug.—Oct.	..	Kankavali, Bhedshi, Phonda ghat.
D. triangulare (Retz.) Merr.		..		Deogad, Bhedshi.
D. triflorum (Linn.) DC.	..	Oct.	..	Konkan, Sawantwadi.
Uraria rufescens (DC.) Schindl.	..	..		Kankavali, Bhedshi, Salsette island.
Zornia diphylla (Linn.) Pers.		Aug.-Sept.	..	Kankavali, Sawantwadi.
Pycnospora lutescens (Roir.) Schindl.		..		Kankavali.
Pseudarthria viseida (Linn.) Wt. and Arn.		Aug.-Sept.	..	Kankavali, Sawantwadi, Vengurla.
Vigna vexillata (Linn.) A. Rich.		..		Kankavali, Bhedshi.
V. pilosa (Willd) Bak.	..	..		Bhedshi.
V. dalzelliana (Kuntze) Verd.		..		Sawantwadi, Bhedshi.
V. radiata (Linn.) Wil.		..		Kankavali, Sawantwadi.
var. *sublobata* (Roxb.) verde.				Sawantwadi.
V. mungo (Linn.) Hepper	..	..		Kankavali, Bhedshi.
Teramnus labialis (Linn. f.) Spreng.		..		Sawantwadi.
Atylosia lineata Wt. and Arn.		Oct.—Dec.	..	Konkan hills.
A. searabaeoides (Linn.) Benth.		..		Deogad, Bhedshi.

Name	Fl. Season	Locality
Aeschynomene indica Linn.	..	Kankavali, Bhedshi, Matheran.
Geissaspis cristata Wt. and Arn.	..	Kankavali, Sawantwadi.
G. tenella Benth. ..	..	Kankavali, Bhedshi.
Smithia conferta Sm. ..	Nov.-Dec. ..	Kankavali, Sawantwadi, Malwan.
S. sensitiva Ait	..	Kudal, Sawantwadi.
S. agharkarii Hem. ..	..	Sawantwadi.
S. hirsuta Dalz.	Sept. ..	Phonda.
S. bigemina Dalz. ..	..	Kankavali, Sawantwadi.
S. salsuginea Hance ..	..	Konkan.
Indigofera nummularifolia (Linn.) Liv. ex, Alston.	..	Malwan.
I. linifolia (Linn. f.) Retz.	July—Oct. ..	Uran, Kankavali.
I. cordifolia Heyne. ex Roth	Aug.—Dec. ..	Uran, Malwan.
I. dalzellii Cooke	July—Sept. ..	Malwan, Sawantwadi, Bhedshi.
I. tinctoria Linn.	Nov.-Dec. ..	Kankavali, Sawantwadi.
I. astragalina DC. ..		Deogad, Sawantwadi.
I. hirsuta L.	Aug.—Oct. ..	Neral.
Tephrosia tinctoria Pers. ..	Oct. ..	Kankavali, Bhedshi.
Sesbania bispinosa (Jacq.) W. F. Wt. ..	..	Malwan, Bhedshi.
S. procumbens (Roxb.) Wt. and Arn.	..	Bhedshi.
S. aculeata Poir	Sept.-Oct. ..	Wet places in Konkan
Moghania strobilifera (Linn.) St. Hil. ex O. Ktze.	..	Kankavali, Bhedshi
M. macrophylla (Willd.) O. Ktze.	..	Kudal, Bhedshi.

Caesalpiniaceae :

Name	Fl. Season	Locality
Bauhinia racemosa Lamk. ..	Mar.—June ..	Hilly part of Konkan, Deogad, Kankavali.
B. tomentosa Linn. ..	Nov.—Jan. ..	..
B. malabarica Dalz. ..	Oct.—Nov. ..	Moist forest.
Caesalpinia bonducella (Linn.) Roxb.	July.—Sept. ..	Deogad, Malwan.
C. crista Linn.	..	Deogad, Malwan.
C. spikata Dalz. ..	..	Deogad, Bhedshi.
C. mimosoides Lamk ..	Oct.—Jan. ..	Sawantwadi, Mahim.
Cassia timorensis DC. ..	Oct. ..	Bhedshi, common in ghat toward Goa.
C. fistula Linn.	Mar.—May ..	Konkan ghat, Kankavali, Bhedshi.
C. mimosoides Linn. ..	Oct.—Dec. ..	Deogad, Sawantwadi.
C. occidentalis Linn. ..	Jan.—Mar. ..	Kankavali, Malwan.

Name	Fl. Season	Locality
C. absus Linn.	Sept.	Bandod, Dapoli, Vengurla, Deogad.
C. tora Linn.	Nov.-Dec.	Kudal, Bhedshi
C. kleinii Wt. and Arn.	..	Konkan, Jambhul
Saraca asoea (Roxb.) dewilde	Dec.—May	South Konkan ghats
Tamarindus indica Linn.	May-June	Kankavali
Mimosaceae		
Mimosa pudica Linn.	Sept.-Oct.	Cultivated at Malwan, Bhedshi.
Acacia farnesiana (Linn.) Willd.	Aug.—Mar.	Deogad, cultivated and naturalised.
A. chundra (Roxb.) Willd.		Kankavali, Bhedshi
A. rugata (Lamk.) Hem. ex Merr.		Deogad, Bhedshi
A. torta (Roxb.) Craib.		Kankavali, Bhedshi
A. pinnata (Linn.) Willd.	June—Aug.	Mumbra near Thane
Neptunia oleracea Lour		
N. triquetra Benth.	Aug.—Oct.	Common in tanks in Bombay.
Albizzia lebbek (Linn.) Benth.	Mar.—May	Kankavali, Bhedshi common.
A. odoratissima (Linn. f.) Benth.	Apr.—June	Kudal, Bhedshi
A. chinensis (Osb.) Merr.		Kankavali, Bhedshi
A. amara Bolvin	Apr.—June	Matheran hills
Entada pursaetha DC.		Kudal, Bhedshi
Xylia xylocarpa (Roxb.) Taub.		
X. *dolabriformis* Benth.	Mar.-Apr.	S. Konkan, Sawantwadi.
Leucaena leucocephala (Lamk.) Dewit.		Sawantwadi—cultivated.
Rosaceae :		
Prunus zeylanica (Wt.) Miq.		Kankavali, Bhedshi
Vahliaceae		
Vahlia digyna (Retz.) O. Ktze.		Kankavali
V. viscosa Roxb.		Bombay
Crassulaceae :		
Kalanchoe pinnata (Lamk.) Pers.		Kankavali, Bhedshi
Droseraceae :		
Drosera burmanni Vahl	Dec.—Feb.	Kudal, Sawantwadi Ratnagiri, Dapoli.
D. indica Linn.	Oct.-Nov.	Deogad, Sawantwadi, Salsette, Vengurla.
Rhizophoraceae :		
Carallia brachiata (Lour) Merr.	Dec.—Mar.	Kankavali, Bhedshi
Rhizophora mucronata Lamk.	Aug.—Dec.	Deogad, Vengurla, along sea coast.
R. conjugata Linn.	Aug.—Dec.	Vengurla, along sea coast.
Ceriops tagal (Perr.) Robins.		Deogad

Name	Fl. Season		Locality
Kandelia candel (Linn.) Druce.		..	Malwan
Bruguiera gymnorhiza (Linn.) Lamk.	Dec.—Feb.	..	Deogad, along sea coast.
B. cylindrica (Linn.) Blume		..	Vengurla along sea coast.
Combretaceae :			
Combretum ovalifolium Roxb.	Jan.—Mar.	..	Jungles in Konkan and in ghats, Elephanta.
C. latifolium Blume		..	Kankavali, Bhedshi
Calycopteris floribunda (Roxb.) Lamk.	Mar.—May	..	Deogad, Bhedshi
Terminalia paniculata Roth ..	Aug.-Sept.	..	Kankavali, Sawantwadi at the foot of ghat.
T. arjuna (Roxb. ex DC.) Bedd.	Apr.-May	..	Matheran, Deogad, Kudal.
T. bellerica (Gaertn.) Roxb.	Feb.—May	..	Kankavali, Bhedshi, at the foot of ghat.
T. crenulata Roth		..	Kankavali, Bhedshi
Anogeissus latifolia Wall. ..		..	Along the rivers and in wells in dry forest also.
T. chebula Retz.	Apr.-May	..	Along the line of ghat near Kudal, Bhedshi.
Luminitzera racemosa Willd.	Jan.—April	..	South Konkan along salt water Creeks, Deogad.
Myrtaceae :			
Syzygium phillraeoides (Trim.) Sant.		..	Kankavali, Sawantwadi.
S. nemisphericum (Walp) Alston.	Mar.-Apr.	..	Konkan, Kankavali, Bhedshi.
S. montanum (Wt.) Gamble ..		..	Kudal
S. caryophyllatum (Linn.) Alston.		..	Deogad, Bhedshi
S. zeylanicum (Linn.) DC. ..		..	Kudal, Bhedshi
S. cumini (Linn.) Skeels ..		..	Kankavali, Bhedshi
S. heyneanum Wall. ex Wt. and Arn.	Mar.—May	..	Kankavali, Bhedshi
Psidium quajava Linn.		..	
Barringtoniaceae :			
Careya arborea Roxb. ..	Mar.-Apr.	..	Common in South Konkan, Kankavali, Bhedshi.
Barringtoniaacutangula (Linn.) Gaertn.	Sep.-Oct.	..	Deogad, Bhedshi
B. racemosa (Linn.) Spreng.	Apr.-May	..	Malwan
Melastomaceae :			
Sonerila scapigera Hook. ..	July-Aug.	..	Sawantwadi
Osbeckia truncata Ge..	Oct.—Dec.	..	Kankavali, Sawantwadi.

Name	Fl. Season	Locality
Melastoma malabathricum Linn.	Oct.—Mar.	Vengurla, Kudal, Bhedshi.
Memecylon umbellatum Burm	Jan.—Mar.	Kankavali, Bhedshi.
M. talbotianum Brand	Mar.-Apr.	Kudal, Bhedshi
Lythraceae :		
Rotala occultiflora Koehne		Kankavli
R. densiflora (Roem. and sch.) Koehne.		Deogad, Sawantwadi.
R.indica (Willd.) Koehne.		Malwan
R. Irotundifolia (Roxb.) Koehne.		Kankavali, Bhedshi
Ammannia multiflora Roxb.	November	Malwan
A. baccifera Linn.	November	Kudal, Sawantwadi
Nesaea lanceolata (Heyne ex Wall.) Koehne.		Malwan
Woodfordia fruticosa (Linn.) Kurz.		Deogad, Bhedshi
Lagerstroemia flos-reginae Roxb.	Apr.—June	Sawantwadi
L. parviflora Roxb.	June	Konkan, Sawantwadi, Matheran hills.
L. microcarpa Wt.	Mar.-Apr.	Kankavali, Bhedshi
L. lanceolata Wall.	Mar.-Apr.	Sawantwadi
Lawsonia inermis Linn.	Apr.—July	Kudal
Sonneratiaceae :		
Sonneratia apetala Buch.-Ham.	February	Salt marshes Bombay, Malwan.
S. caseolaris (Linn.) Engl.		Deogad, Vengurla
Onagraceae :		
Ludwigia octovalvis (Jacq.) Raven ssp.		In fresh watertanks at Kankavali, Bhedshi.
Sessiliflora (Mich) Rav.		
L. perennis Linn.		Malwan, Sawantwadi.
L. hyssopifolia (G. Don) Exell.		Malwan, Bhedshi
Passifloraceae :		
Passiflora foetida Linn.		Deogad
Adenia hondala (Gaertn.) De Wilde.		Sawantwadi
Cucurbitaceae :		
Tricosanthes bracteata (Lamk.) Voigt.		Kankavali, Bhedshi
T. cucumerina Linn.	July—Oct.	Deogad, Sawantwadi.
Luffa acutangula (Linn.) Roxb.	June—Sept.	Kankavali, Bhedshi
var *amara* (Roxb.) C. B. Cl.		
L. cylindrica (Linn.) Roem.		Sawantwadi
Momordica charantia Linn.	May –Aug.	Deogad, Sawantwadi.
M. dioica Roxb. ex. Willd.	June—Aug.	Kankavali, Sawantwadi.

Name	Fl. Season	Locality
Coccinia grandis (Linn.) Voigt.	..	Malwan, Sawantwadi
Zahnaria scabra (Linn. f.) Sond.	..	Kankavali
Mukia maderaspatana (Linn) Roem.	..	Malwan, Sawantwadi.
Solena heterophylla Lour. ..	..	Kankavali, Bhedshi
Kedrostis rostrata (Rottl.) Cogn.	Sept.--Nov. ..	Sawantwadi
Dicaelospermum ritchiei C. B. Cl.	July—Sept. ..	Kankavali
Begoniaceae :		
Begonia crenata Dryand. ..	Aug.-Sept. ..	Deogad, Sawantwadi.
Tetramelaceae :		
Tetrameles nudiflora R. Br.	Feb.-Mar. ..	Kankavali, Sawantwadi.
Aizoaceae :		
Mollugo pentaphylla Linn. ..	Sept.—Nov. ..	Kankavali, Sawantwadi.
Glinus lotoides Linn. ..	..	Sawantwadi
G. oppositifolius (Linn.) A. DC.	..	Deogad, Bhedshi
Apiaceae :		
Centella asiatia (Linn.) Urb.	..	Sawantwadi
Hydrocotyle sibthorpioides Lamk.		Sawantwadi
Pimpinella heyneana (DC.) Kurz.	Aug.—Oct. ..	Kankavali, Bhedshi
P. monoica Dalz.	November ..	Kankavali, Sawantwadi.
P. adscendens Dalz.	Jan.-Feb. ..	Vengurala
Heracleum concanense Dalz.	July-Aug. ..	Kankavali, Sawantwadi.
Araliaceae :		
Schefflera venulora (Wt. and Arn.) Harms.	..	Kankavali, Bhedshi
Rubiaceae :		
Anthocephalus chinensis (Lamk.) Rich. ex. Walp.	Nov.—Feb. ..	Kankavali, Sawantwadi.
Adina cordifolia (Roxb.) Hook. f. ex Brand.	June—Sept. ..	Kudal
Mitragyna parvifolia (Roxb.) Korth.	May—Aug. ..	Kankavali, Sawantwadi.
Morinda tomentosa Heyne ex Roth.	..	Deogad
Heymenodictyon aboratum Wall.	..	Sawantwadi
Wendlandia thyrsoidea (R. and S.) Steud.	..	Kankavali, Bhedshi
ussaenda fabrata (Hook. f.) Huch.	..	Kudal, Bhedshi
Ixora nigricans R. Br. ex Wt. and Arn.	All the year ..	Kankavali, Bhedshi

Name	Fl. Season	Locality
I. coccinia Linn.	All the year	Kankavali, Bhedshi
I. brachiata Roxb.	Nov.—Feb.	Deogad, Bhedshi
Pavetta crassicaulis Bremek.		Kankavali, Bhedshi
P. tomentosa Roxb. ex Sm.		Malwan
P. siphonantha Dalz.		Kankavali, Bhedshi
Psychotria truncata Wall.	Apr.-May	Sawantwadi
Chassalia ophioxyloides (Wall.) Graib.		Sawantwadi
Xeromphis spinosa (Thunb.) Keayn.		Kudal, Sawantwadi
X. uliginosa (Retz.) Maheshwari.		Kankavali, Bhedshi
Gardenia turgida Roxb.	Apr.—June	Kankavali
Canthium dicoccum (Gaertn). Teysm. and Binn.		Kudal, Bhedshi
C. angustifolium Roxb.		Kankavali, Sawantwadi.
Meyna laxiflora Robyns		Kankavali, Bhedshi
Randia rugulosa (Thw.) Hook. f.	Jan.—Mar.	Sawantwadi
Borreria pusilla (Wall.) DC.		Deogad, Sawantwadi
B. ocymoides (Burm. f.) DC.		Malwan
B. articularis (Linn.) F. N. will.		Kankavali, Sawantwadi.
Neanotis lancifolia (Hook. f.) Lewis.		Kankavali, Sawantwadi.
N. rheedii (Wall. ex Wt. and Arn.) Lewis.		Sawantwadi
N. montholoni (Hook. f.) Lewis.		Sawantwadi
N. foetida (Hook. f.) Lewis		Kankavali, Sawantwadi.
Hedyotis auricularia Linn.		Kankavali, Bhedshi
H. trinervia (Retz.) R. and S.		Malwan
H. maheshwarii (Sant. and Merch.) Rao and Hem.		Sawantwadi
H. herbacea Linn.		Kankavali, Bhedshi
H. corymbosa (Linn.) Lamk.		Kankavali, Sawantwadi.
Ophiorrhiza prostrata D. Don.		Sawantwadi
Dentella repens (Linn.) J. R. and G. Forst.		Deogad, Bhedshi
Rubia cordifolia Linn.	Oct.—Jan.	Sawantwadi
Asteraceae :		
Crepis acaulis Hook. f.		Sawantwadi
Launea fallax (Jaub-et Spach.) O. Kunt.		Deogad, Malwan.
Elephantopus scaber Linn.	Sept.—Nov.	Kankavali, Sawantwadi.
Sphaeranthus indicus Linn.	Nov.—Jan.	Kudal, Sawantwadi
S. africanus Linn.	October	Deogad
Gynura cusimbua (D. Don) Moore.		Konkan, Bhedshi
Emilia sonchifolia (Linn.) DC. ex Wt.		Deogad, Bhedshi

Name	Fl. Season	Locality
Adenostemma lavenia (Linn.) O. Kuntze.		Kankavali, Bhedshi
A. geratum conyzoides Linn.		Kankavali, Bhedshi
Dichrocephala integrifolia (Linn.) O. K.		Sawantwadi
Cyathocline purpurea (Don) O. K.		Kankavali. Bhedshi
Adenoon indicum Dalz.	Sept.-Oct.	Sawantwadi.
Blumea malcolmii (C. B. Cl.) Hook. f.	Nov.—Feb.	Kankavali, Sawantwadi.
B. belangerian DC.	Dec.—Mar.	Kudal, Bhedshi
B. eriantha DC.	Dec.—Feb.	Kudal
B. oxyodenta DC.	Jan.—Mar.	Kudal, Bhedshi
B. virens DC.	Dec.-Jan.	Kudal, Bhedshi
B. membranacea DC.	May	Sawantwadi
B. solidaginoides (Poir.) DC.		Kankavali, Bhedshi
B. lacera (Burm. f.) DC.		Kankavali, Bhedshi
Conyza stricta Willd.	Oct.-Nov.	Bhedshi
C. leucantha (D. Don) Ludl. and Rav.		Sawantwadi
Helichrysum indicum (1) Griers.		
Centratherum phyllolaenum (DC.) Benth and C. B. Cl.	Sept.-Oct.	Kankavali, Sawantwadi.
Tricholepis glaberrima DC.	December	Sawantwadi, Deogad.
Vernonia cinerea (Linn.) Less.	Jan.-Feb.	Kankavali
V. divergens (Roxb.) Edgew.	Dec.-Feb.	Kankavali, Vengurla.
Epaltes divaricata cass.	Oct.—Jan.	Sawantwadi
Centipeda minima (Linn.) A. Br. and Asch.		
Synedrella nodiflora (Linn.) Gaertn.		Malwan, Sawantwadi.
Tridax procumbens Linn.	All the year	Deogad, Sawantwadi.
Blainvillea acmella (Linn.) Philips on.		Vengurla
Melanthera biflora (Linn.) H. Wilde.		Deogad
Eclipta prostrata (Linn.)		Deogad, Sawantwadi.
Senecio edgeworthii Hook. f.	Aug.—Nov.	Sawantwadi
S. grahamii Hook. f.	Aug.—Dec.	Kankavali, Sawantwadi.
S. belgaumensis (Wt.) C. B. Cl.	Aug.—Jan.	Deogad, Bhedshi
Pulicaria angustifolia DC.	Nov.-Dec.	Deogad, Malwan
Guizotia abyssinica (Linn. f.)		Kankavali
Tithonia diversifolia (Hemsl.) Gray.		Sawantwadi
Sphenocleaceae ;		
Sphenoclea zeylanica Gaertn.	Oct.—Dec.	Deogad, Malwan

Name	Fl. Season	Locality
Lobeliaceae :		
Lobelia alsinoides Lamk. ..	..	Kankavali, Bhedshi
L. nicotianaefolia Heyne ..	Nov.—Mar. ..	Kankavali, Sawantwadi.
Plumbaginaceae :		
Plumbago zeylanica Linn. ..	Aug.-Sept. ..	Deogad
Primulaceae :		
Anagallis pumila Sw. ..	..	Sawantwadi
Myrsinaceae :		
Embelia ribes Burm. f. ..	February ..	Sawantwadi
E. bassal (R. and S.) A. DC.	..	Sawantwadi
E. tsjeriam-cottam (R. and S.) A. DC.	..	Kankavali, Sawantwadi.
Aegiceros corniculatum (Linn.) Blanc.	..	Deogad, Malwan
Maesa indica (Roxb.) Wall..	Nov.—Jan. ..	Kankavali, Bhedshi
Ardisia olanacea (Poir.) Roxb.	Apr.—June ..	Kudal, Bhedshi
Sapotaceae :		
Xantolis tomentosa (Roxb.) Raf.	..	Kankavali, Bhedshi
Mimusops elengi Linn. ..	Jan.—Mar. ..	Kankavali, Sawantwadi.
Ebenaceae :		
Diospyros nigrescens (Dalz.) Sald.	..	Kudal, Bhedshi
D. malabarica (Desr.) Kostel.		Sawantwadi
D. oocarpa Thw.	Jan.—Mar. ..	Kankavali, Kudal
D. montana Roxb.	Jan.—Apr. ..	Kankavali, Bhedshi
D. candolleana Wt.	Feb.—June ..	Kudal, Bhedshi
Symplocaceae :		
Symplocos laurina Wall. ex. Rehl and Wills.	..	Kudal, Bhedshi
S. beddomei C. B. Cl. ..	Nov.—Jan. ..	Sawantwadi, Bhedshi.
Oleaceae :		
Jasminum rottlerianum Wall. ex. DC.	..	Kudal, Bhedshi
J. malabaricum Wt.	Mar.—May ..	Kankavali, Bhedshi
J. sambac Ait.	All the year ..	Kudal
J. ritchiei C. B. Cl.	Aug.-Sept. ..	Kankavali, Sawantwadi.
Ligustrum perrottetii A. DC.	..	Kankavali, Bhedshi
Olea dioica Roxb.	Jan.—Apr. ..	Bhedshi
Apocynaceae :		
Carissa congesta Wt. ..	..	Bhedshi
C. inermis Vahl.	Jan.-Feb. ..	Kudal, Bhedshi

Name	Fl. Season	Locality
Chonemorpha fragrans(Moon) Alston.		Kudal, Bhedshi
Parsonsia helicandra Hook. f. Arn.		Kudal, Bhedshi
Aganosoma cymosa (Roxb.) G. Don.	Apr.—June	Kudal, Bhedshi
Anod ndron paniculatum A. D C.	Dec.—Mar.	Kankavali, Bhedshi
Ichnocarpus frutescens (L.) R. Br.	Nov.-Dec.	Sawantwadi, Bhedshi.
Cerbera manghas Linn.		Malwan
Holarrhena antidysenterica (L.) Wall. ex G. Don.	Feb.—June	Deogad, Bhedshi
Wrightia tinctoria R. Br.	Mar.—May	Kudal, Bhedshi
Ervatamia heyneana (Wall.) Cooke.	Mar.-Apr.	Kankavali, Bhedshi
Alstonia scholaris (L.) R. Br.	Dec.—Mar.	Kankavali, Bhedshi
Rauwolfia serpentina (L.) Bth. ex Kurz.	Mar.—May	Kankavali, Bhedshi
R. densiflora (Wall.) Bth. ex Hook. f.	Mar.-Apr.	Kudal, Sawantwadi
Thevetia peruviana (Perss) K. Sch.		Sawantwadi
Asclepiadaceae		
Ceropegia sahyadrica Ans. and Kul.		Sawantwadi
C. pusilla Wt. and Arn.		Sawantwadi
C. hirsuta Wt. and Arn.	August	Malwan
C. oculata Hook.	Aug.-Sept.	Kudal, Sawantwadi
Asclepias curassavica Linn.		Kudal
Calotropis gigantea (Linn.) R. Br.		Kankavali, Bhedshi
Hoya wightii Hook. f.	Oct.—Dec.	Kudal, Bhedshi
Genianthus laurifolius (Roxb.) Hook. f.		Bhedshi
Holostemma annulare (Roxb.) K. Sch.		Kankavali, Sawantwadi.
Dregia volubilis (L.) Bth. ex. Hook. f.		Deogad, Kudal
Tylophora fasciculata Ham.	July-Aug.	Bhedshi
T. dalzellii Hook. f.	August	Kudal, Bhedshi
T. indica (Burm. f.) Merr.		Kudal, Bhedshi
Gymnema sylvestre (Retz.) Schult	Apr.-May	Kudal, Bhedshi
Heterostemma dalzelli Hook. f.	August	Vengurla
Cynanchum callialata Ham.	Oct.—Jan.	Sawantwadi, Bhedshi.
Leptadenia reticulata (Retz.) W. and A.	Apr.—July	Malwan
Periplocaceae		
Hemidesmus indicus Schult.		Kankavali, Bhedshi
Cryptolepis buchanani R. and S.		Deogad, Bhedshi

Name	Fl. Season	Locality
Loganiaceae		
Cynotonum mitreola (L.) Britt.	..	Sawantwadi
Buddleia asiatica Lour.	Jan.—Apr.	Kankavali
Strychnos colubrina Linn.	Oct.—Jan.	Bhedshi
S. nuxvomica Linn.	Mar.-Apr.	Kankavali, Bhedshi
Gentianaceae :		
Canscora perfoliata Lamk.	Feb.	Kudal, Bhedshi
C. diffusa (Vahl) R. Br.	Oct.—Jan.:	Kankavali, Bhedshi
C. decurrens Dalz.	Oct.—Dec.	Kankavali, Kudal
Exacum lawii C. B. Cl.	Oct.	Sawantwadi
E. pumilum Griseb.	Aug.-Sept.	Kankavali, Sawantwadi.
E. bicolor Roxb.	Aug.—Nov.	Kankavali, Bhedshi
E. petiolare Griseb.	..	Kankavali, Sawantwadi.
Centaurium centaurioides (Roxb.) Rao and Ham.	..	Kankavali, Bhedshi
Hydrophyllaceae		
Hydrolea zeylanica (Hinn.) Vahl.	Nov.-Dec.	Kankavali, Bhedshi
Boraginaceae :		
Ehretia laevis Roxb.	Jan.—June	Sawantwadi
E. canarensis Mig. ex C. B. Cl.	..	Kankavali, Sawantwadi.
Rotula aquatica Lour.	..	Kankavali, Bhedshi
Cordia dichotoma Forst. f.	..	Kankavali, Bhedshi
Coldenia procumbens Linn.	Sept.-Oct.	Kudal, Bhedshi
Heliotropium indicum Linn.	Oct.—Dec.	Kankavali, Kudal
H. cornutum Johnst.	..	Deogad, Sawantwadi.
H. strigosum Willd.		
Irichodesma sedgwic kianum Ban.	..	Kankavali.
Cynoglossum meeboldii Brand.	..	Kankavali, Sawantwadi.
Adelocaryum coelestinum (Lindl.) Brand.		Vengurla, Sawantwadi.
Convolvulaceae :		
Evolvulus alsinoides (L.) L.	July—Nov.	Deogad, Malwan.
Rivea hypocrateriformis (Desv) Choisy.	Aug.—Oct.	Sawantwadi
Stictocardia tiliifolia (Desr.) Hall. f.	..	Kankavali, Kudal.
Argyreia hookeri C. B. Cl.	Aug.-Sept.	Kudal, Bhedshi
A. elliptica Choisy	..	Kankavali, Bhedshi
Ipomoea aquatica Forsk.	..	Deogad.
I. eriocarpa R. Br.	Sept.-Oct.	Sawnatwadi.
I. macrantha R. and S.	..	Malwan.
I. hederifolia Linn.	..	Kankavali
I. maxima (Linn. f.) G. Don ex Sw.	..	Deogad, Malwan

Name	Fl. Season	Locality
I. curassavica All.	..	Deogad, Kudal
I. pes-caprae (Linn.) Sw.	..	Malwan
I. pes-tigridis Linn.	Sept.—Nov.	Kankavali, Malwan
I. digitata Linn.	July—Sept.	Deogad, Sawantwadi.
I. diversifolia R. Br.	..	Malwan, Sawantwadi.
I. fistulosa Mart. ex Choisy	..	Kankavali
Porana racemosa Roxb.	..	Kankavali
Hewittia sublobata (Linn. f.) o. k.	..	Sawantwadi
Merremia tridentata (L.)Hall. f.	Aug.—Oct.	Deogad, Bhedshi
M. vitifolia (Burm. f.) Hall. f.	Oct.—Dec.	Kankavali, Bhedshi
M. umbellata (L.) Hall. f. var. *orientalis* (Hall. f.) Van Oost.	Jan.-Feb.	Kankavali, Bhedshi
Solanaceae :		
Physalis minima Linn.	Aug.	Deogad, Bhedshi
Datura metel Linn.	..	Deogad, Sawantwadi.
Solanum giganteum Jacq.	Jan.—Mar.	Bhedshi
S. indicum Linn.	Aug.—Oct.	Kankavali, Bhedshi
Lycianthes bigeminata (Nees) Bitt.	May-June	Kudal
Scrophulariaceae :		
Dopatrium Junceum (Roxb.) Buch. Ham. ex Benth.	July—Sept.	Sawantwadi
Bacopa floribunda (R. Br.) Wettst.	Oct.	Malwan
Limnophila repens (Benth.) Benth.	Feb.	Kudal, Sawantwadi
L. indica (Linn.) Druce	Nov.—Feb.	Sawantwadi
L. aquatica (Roxb.) Alston	Oct.—Apr.	Sawantwadi, Bhedshi
Torenia indica Sald	Aug.—Oct.	Kankavali, Sawantwadi.
T bicolor Dalz.	July	Sawantwadi
Lindernia pusilla (Willd.) Bold.	Feb.	Sawantwadi
L. viscosa (Hornem.) Merr.	Aug.—Oct.	Sawantwadi
L. rotundifolia (Linn.) Muk.	Oct.—Feb.	Kankavali, Bhedshi
L. crustacea (Linn.) F. Muell.	Oct.—July	Kankavali, Bhedshi
L. anagallis (Burm. f.) Penn.	May-June	Sawantwadi, Bhedshi
L. hyssopioides (Linn.) Haines	Feb.	Bhedshi
L. parviflora (Roxb.) Haines	Aug.—May	Kankavali, Sawantwadi.
L. ciliata (Colsm.) Penn.	Aug.	Kankavali, Sawantwadi.
L. oppositifolia (Retz.) Muk.	Aug.—June	Kankavali, Sawantwadi.
Striga gesnerioides (Willd.) Vatke.	Aug.—Apr.	Deogad, Sawantwadi.

Name	Fl. Season	Locality
S. asiatica (L.) O. Kuntze ..	Aug.—Oct. ..	Kankavali, Sawantwadi.
Rhamphicarpa longiflora (Arn.) Bth.	Aug.—Oct. ..	Deogad, Sawantwadi.
Sopubia delphinifolia (Roxb.) G. Don.	Aug.—Oct. ..	Sawantwadi
Centranthera indica (L.) Gamble.	Sept.—Nov. ..	Kankavali, Sawantwadi.
Scoparia dulcis L.	..	Kudal, Bhedshi
Orobanchaceae		
Aeginetia indica L. ..	..	Kankavali, Sawantwadi.
Lentibulariaceae		
Utricularia nivea Vahl. ..	..	Sawantwadi
U. ulginosa Vahl. ..	..	Kankavali, Sawantwadi.
U. reticulata Sm. ..	Oct. ..	Kankavali, Sawantwadi.
U. striatula Sm.	Sept. ..	Kankavali, Sawantwadi.
Gesneriaceae :		
Rhynchoglossum potianum (Wall.) Burtt.	..	Kankavali, Sawantwadi.
R. obliqum Bl. Var. *Parviflorum* C. B. Clarke	Oct. ..	Kankavali, Sawantwadi.
Epithema carnesum Benth.	..	Sawantwadi.
Bignoniaceae :		
Oroxylum indicum (Linn.) Vent.	May—July ..	Sawantwadi
Heterophragma quadriloculare (Roxb.) K. Sch.	Feb.—Apr. ..	Kankavali, Bhedshi
Stereospermum personatum (Hassk.) Chatt.	..	Kankavali, Bhedshi
Pedaliaceae :		
Pedalium murex Linn. ..	Oct. ..	Malwan
Sesamum mulayanum Nair.	..	Kankavali, Malwan
S. orientale Linn. ..	..	Kankavali, Sawantwadi.
Martyniaceae :		
Martynia annua Linn. ..	..	Deogad
Thunbergiaceae :		
Thunbergia laevis Nees ..	..	Sawantwadi
Acanthaceae :		
Acanthus ilicifolius Linn. ..	Apr.-May ..	Deogad, Vengurla
Nelsonia canescens (Lam.) Spr.		Kudal, Bhedshi
Staurogyne zeylanica (Nees) o. Kuntze.		Kudal, Sawantwadi
Hygrophila auriculata (Sch.) Heine.		Kudal

Name	Fl. Season	Locality
H. pinnatifida (Dalz.) Sreem		Malwan, Bhedshi
Haplanthus verticillatus (Roxb.) Nees.	Dec. ..	Kudal
H. neilgherryensis Wt. ..		Kudal, Bhedshi
Lepidagathis cuspidata (Wall.) Nees.	Mar. ..	Kankavali
L. lutea Dalz. ..	Nov. ..	Deogad, Malwan
L. prostrata Dalz. ..	Dec. ..	Malwan
L. fasciculata (Retz.) Nees ..	Feb. ..	Kudal, Bhedshi
Barleria prionitis Linn. ..	Oct.—Jan. ..	Deogad, Bhedshi
B. cristata Linn. ..	Dec. ..	Kankavali Sawantwadi.
B. strigosa willd. *varterminalis* (Nees) C. B. Cl.	Nov.—Dec. ..	Kankavali, Bhedshi
B. prattensis Sant. ..		Malwan.
Dicliptera zeylanica Nees ..	Dec.—Mar. ..	Kudal, Bhedshi
Blepharis asperrima Nees ..	Oct.—Dec. ..	Kankavali, Sawantwadi.
Andrographis paniculata (Burm. f.) wall. ex Nees.	Dec. ..	Malwan
Asystasia dalzelliana Sant. ..		Kankavali, Sawantwadi.
Gymnostachyum glabrum (Dalz.) T. And.	Dec.—Feb. ..	Sawantwadi
Rhinacanthus nasutus (*L.*) Kurz		Sawantwadi
Thelepaepale ixiocephala (Bth.) Brem.		Kudal, Bhedshi
Rungia pectinata (L.) Nees ..	Nov.—Feb. ..	Deogad, Bhedshi
Mackenzia integrifolia (Dalz.) Brem.		Kudal, Sawantwadi
Pseuderanthemum malabaricum (C. B. Cl.) Gamble		Deogad, Malwan
Justicia betonica Linn. ..	Oct.—Dec. ..	Kankavali, Bhedshi
J. wynaadensis (Nees) T. Anders.	Nov.—Dec. ..	Bhedshi
J. trinervia Vahl. ..	Oct.—Jan. ..	Sawantwadi
J. procumbens Linn. ..	Oct.—Mar. ..	Kankavali, Malwan
J. simplex D. Don. ..	Nov.—Dec. ..	Kudal, Bhedshi
Hemigraphis latebrosa (Heyn- ex Roth) Nees.	Dec. ..	Kudal, Bhedshi
Neucanthus sphaerostachyus (Nees) Dalz.	Sept.—Oct. ..	Deogad, Malwan
Phaulopsis dorsiflora (Retz.) Sant.		Sawantwadi
Ecbolium viride var. *laetevirens* (C. B. Cl.) Sant.	Oct.—Jan. ..	Deogad, Bhedshi
Eranthemum roseum (Vahl.) R. Br.		Kankavali, Bhedshi
Adhatoda vasica (Linn.) Nees	Aug.—Nov. ..	Sawantwadi
Calacanthus grandiflorus (Dalz.) Radlk.		Kankavali, Bhedshi
Curvia callosa (Wall.) Brem.		Kankavali, Sawantwadi.
Nigirianthus warreensis (Dalz.) Brem.		Bhedshi
N. lupulinus (Wall.) Brem.		Sawantwadi

Name	Fl. Season	Locality
N. heyneanus var. *neesii* Brem.		Sawantwadi, Bhedshi
N. reticulatus (Stapf.) Brem.		Sawantwadi
Verbenaceae :		
Phyla nodiflora (L.) Greene		Malwan
Avicennia officinalis Linn. ..	Apr.—June ..	Deogad, Kudal
A. marina var. *acutissimas* tapf ex Mold. ex Mold.		Deogad, Vengurla
Lantana camara L. var. *aculeata* (L.) Mold.	All the year ..	Kankavali, Bhedshi
Vitex altissima Linn. f. ..	May ..	Kankavali, Bhedshi
V. leucoxylon Linn. f. ..	Feb.—Apr. ..	Kankavali, Bhedshi
V. negundo L. ..	All the year ..	Malwan, Vengurla
V. trifolia L.	All the year ..	Kudal, Bhedshi
Callicarpa tomentosa (L.) Murr.		
Tectona grandis Linn. f. ..	Jun.—Sept. ..	Sawantwadi
Gmelina arborea Roxb. ..	Mar.—May ..	Kudal, Bhedshi
Premna coriacea C. B. cl. ..	Mar.—May ..	Sawantwadi
P. corymbosa (Burm. f.) Rott. C. Willd.		Kudal, Sawantwadi
Clerodendrum serratum (L.) Moon.	Aug.-Sept. ..	Kankavali, Sawantwadi.
C. viscosum Vent. ..		Deogad, Sawantwadi.
C. philippinum Schauer		
Lamiaceae		
Leucas ciliata Bth. ..	Oct.—Jan. ..	Kankavali, Bhedshi
L. mollissima Wall. ex Benth.	Aug.—Dec. ..	Kankavali, Kudal
L. biflora (Vahl) R. Br. ..	Oct. ..	Kankavali, Bhedshi
L. lavandulaefolia J. E. Sm.		Kankavali, Bhedshi
L. aspera (Willd.) Spreng. ..	Oct.	Malwan.
L. stelligera Wall. ex Benth.	Nov. ..	Kankavali, Bhedshi
Scutellaria discolor Wall. ex Benth.		Sawantwadi
Orthosiphon thymiflorus (Roth) Slees.		Deogad, Sawantwadi.
Ocimum gratissimum Linn	July—Oct. ..	Kudal, Sawantwadi
O. americanum Linn. ..		Bhedshi
Acrocephalus indicus (Burm.f. o. Kuntze.		Kankavali, Bhedshi
Anisochilus verticillatus Hook. f.	Oct. ..	Kankavali
Plectranths stocksii Hook. f.	Sept.—Nov. ..	Kankavali, Sawantwadi.
P. mollis (Ait.) Spreng ..		Sawantwadi
Colebrookia oppositifolia Sm	Dec.—Apr. ..	Kudal, Sawantwadi
Dysophylla stellata (Lour.) Bth.	Nov.—Jan. ..	Kankavali, Sawantwadi.
Pogostemon benghalense (Burm. f.) O. Kuntze.	..	Kankavali, Bhedshi
P. purpurascens Dalz. ..	Oct.—Jan. ..	Sawantwadi, Bhedshi.
Hyptis suaveolens (Linn.) Poit.	..	Deogad, Sawantwadi.

Name	Fl. Season	Locality
Anisomeles indica (L.) Ktze.	..	Kankavali, Bhedshi
A. heyneana Benth.	Oct.-Nov.	Kankavali, Bhedshi
Nyctaginaceae		
Boerhaavia diffusa Linn.	Nov.	Malwan
Amaranthaceae		
Cyathula prostrata (L.) Bl.	..	Kankavali, Bhedshi
Alternanthera sessilis (L.) DC.	..	Kankavali, Bhedshi
Aerua sanguinolenta (L.) Bl.	..	Kankavali, Sawantwadi.
Amaranthus tricolor Linn.	..	Malwan
Celosia argentea Linn.	Oct.—Dec.	Deogad, Bhedshi
Achyranthes aspera L. var. *porphyristachya* Hook. f.	..	Kankavali, Sawantwadi.
Polygonaceae		
Polygonum plebejum R. Br.	Dec.—Mar.	Kudal, Bhedshi
P. chinense Linn.	Nov.—Apr.	Kankavali, Bhedshi, Sawantwadi
P. strictum Allioni	..	
P. glabrum Willd.	Oct.—Mar.	Kankavali, Sawantwadi.
P. barbatum L. var. *gracile* Stew.	..	Kudal, Bhedshi
Podostemaceae :		
Polypleurum stylosum (Wt.) J. B. Hall.	..	Sawantwadi
Terniola zeylanica (Gardn.) Tul.	..	Kudal, Sawantwadi
Griffithella hookeriana (Tul.) Warm.	Oct.—Dec.	Bhedshi
Piperaceae :		
Peperomia pellucida (Linn.) H. B. and K.	..	Vengurla, Sawantwadi.
Piper hookeri Miq.	Apr.—Sept.	Sawantwadi
P. trachostachyon (Miq.) C. DC.	..	Sawantwadi
Myristicaceae		
Knema attenuata (Hook. F. and Thoms.) Warb.	..	Sawantwadi
Lauraceae		
Cassytha filiformis Linn.	Sept.	Vengurla
Alseodaphne semecarpifolia Nees.	July—Dec.	Kudal
Litsea deccanensis Gamble	..	Kankavali, Sawantwadi.
L. stocksii Hook f.	Sept.-Oct.	Sawantwadi
Neolitsea zeylanica (Nees) Merr.	..	Kudal, Sawantwadi
Cinnamomum verum Presl	..	Sawantwadi, Bhedshi.
Cryptocarya wightiana Thw.	Dec.—Apr.	Sawantwadi

Name	Fl. Season	Locality
Persea macrantha (Nees) Kosterm.	..	Kankavali
Beilschmiedia dalzellii (Meissn.) Kosterm.	..	Sawantwadi
Thymelaeaceae :		
Lasiosiphon eriocephalus Deche.	Dec.—May ..	Kankavali, Sawantwadi.
Elaeagnaceae :		
Elaeagnus conferta Roxb. ..	..	Kudal, Bhedshi
Loranthaceae :		
Viscum monoicum DC. ..	Sept. ..	Sawantwadi
V. angulatum Heyne ex DC.	All the year ..	Kankavali, Bhedshi
Macrosolen capitellatus (Wt. and Arn.) Danser.	..	Kankavali, Bhedshi
Helixanthera wallichiana (Schult.) Dans.	..	Bhedshi
Scurrula philippinsis (Cham and Schl.) G. Don.	..	Kudal, Bhedshi
Helicanthes elastica (Desr.) Dans.	..	Kankavali, Sawantwadi.
Dendrophthoe falcata (Linn. f.) Etting.	..	Kudal, Bhedshi
D. trigona (W. and A.) Dans. ex Sant.	..	Kudal, Bhedshi
Santalaceae		
Osyris wightiana Wall. ex Wt.		
Euphorbiaceae		
Euphorbia panchganiensis Blatt. and M. C.		
E. pycnostegiac Boiss. ..	..	Kankavali, Sawantwadi.
E. notoptera Boiss. ..	Oct.—Dec. ..	Deogad, Sawantwadi.
E. parviflora Linn. ..	..	Kankavali, Bhedshi
E. hirta Linn.	..	Kudal, Bhedshi
E. microphylla Heyn. ex Roth	..	Sawantwadi
E. thymifolia Linn. ..	All the year ..	Kankavali, Kudal
Phyllanthus emblica Linn. ..	Mar.—May ..	Kankavali, Bhedshi
P. reticulatus Poir ..	All the year ..	Kankavali, Bhedshi
P. lawii Grah. ..	Sept.-Oct. ..	Kankavali, Bhedshi
P. urinaria Linn. ..	Aug.	Sawantwadi
P. virgatus Forst. f. ..	..	Kankavali, Bhedshi
P. asperulatus Hutch ..	..	Kudal, Sawantwadi
Microcca mercurialis (L.) Bth.	..	Deogad, Sawantwadi.
Tragia muelleriana var. *Unicolor* (M. Arg.) Pax and Hoffm.	.. ..	Kankavali, Bhedshi Deogad, Bhedshi
Bridelia scandens (Roxb.) Willd.	..	Deogad, Sawantwadi.
B. retusa (L.) Spr. ..	May—Oct. ..	Kankavali, Bhedshi

Name	Fl. Season	Locality
B. squamosa (Lamk.) Graham	..	Deogad, Bhedshi
Securinega virosa (Roxb. ex Willd.) Baill.		
Actephila excelsa (Dalz.) M. Arg.	..	Kankavali, Sawantwadi.
Glochidion velutinum Wt. ..	Dec.—Mar. ..	Bhedshi
G. zeylanicum (Gaertn.) A. Juss.	Oct.—June ..	Deogad, Bhedshi
G. hohenackeri Bedd. ..	Dec.—Apr. ..	Kankavali, Bhedshi
Breynia retusa (Dennst.) Alston. ..	..	Kankavali, Bhedshi
B. vitisidea (Burm. f.) C. E. C. Fisch.:	..	Sawantwadi, Bhedshi.
Croton oblongifolius Roxb.	..	Deogad.
Agrostistachys indica Dalz.	Feb. ..	Sawantwadi.
Dimorphocalyx lawianus (M. Arg.) Hook f.	Mar.—Oct. ..	Kankavali, Sawantwadi.
Blachia denudata Benth ..	..	Kankavali, Sawantwadi.
Antidesmia acidum Retz. ..	..	Kudal, Bhedshi
A. ghaesembilla Gaertn. ..	May—July ..	Vengurla
A. menasu Mig.	Feb.—May ..	Kudal, Bhedshi
Sapium insigne (Royle) Bth. var. *malabaricum* (Wt.) Hook. f.	Dec.—Feb. ..	Kudal, Bhedshi Kankavali.
Homonia riparia Lour. ..	Jan.—Apr. ..	Kudal, Bhedshi
Macaranga peltata (Roxb.) M.-Arg.	..	Sawantwadi
Drypetes venusta (Wt.) Pax and Hoffm.	..	Kudal
D. roxburghii (Wall.) Hurus.	..	Kudal, Bhedshi
Mallotus philippensis (Lamk.) M.-Arg.	Nov.—Jan. ..	Kankavali, Sawantwadi.
M. stenanthus M.-Arg. ..	Sept.-Nov. ..	Sawantwadi
M. aureo-punctatus (Dalz.): M.-Arg.	..	Kankavali, Vengurla
Irewia polycarpa Bth. ..	..	Kankavali, Bhedshi
Aporusalindleyana Baill. ..	Dec.—Feb. ..	Malwan.
Jatropha gossypifolia Linn. ..	..	Kankavali, Sawantwadi.
J. curcas Linn.		
Pedilanthus tithymaloides (L.) Poit.	..	Kankavali, Kudal
Ulmaceae :		
Holoptelea integrifolia (Roxb.) Planch.	..	Bhedshi
Celtis cinnamomea Lindl. ex Planch.	..	Sawantwadi, Bhedshi.
Irema orientalis (Linn.) Bl.	..	Sawantwadi, Bhedshi.
Urticaceae :		
Boehmeria scabrella (Roxb.) Gaud.	Apr.—Oct. ..	Kankavali, Sawantwadi.
Debregeasia longifolia (Burm.) Wedd.	..	Deogad.

Name	Fl. Season	Locality
Laportea interrupta (L.) Chew.	..	Sawantwadi.
Girardinia zeylanica Decne.	..	Kankavali, Sawantwadi.
Pouzozia zeylanica (L.) Benn.		Deogad, Sawantwadi.
Elatostema cuneatum Wt. ..	..	Kankavali, Malwan
Lecanthus peduncularis (Royle) Wedd.	..	Sawantwadi
Moraceae :		
Ficus tinctoria Forst. f. SSP. *parasitica* Corn. var. *parasitica* Corn.	..	Kankavali, Vengurla
F. heterophylla Linn. f. ..	..	Bhedshi
F. hispida Linn. f.	..	Deogad, Bhedshi
F. asperrima Roxb.	..	Kankavali, Bhedshi
F. racemosa Linn.	..	Kankavali, Sawantwadi.
F. benghalensis Linn. ..	..	Kankavali, Bhedshi
F. arnottiana Miq. ..	..	Deogad, Bhedshi
F. drupacea Thunb. var. *pubescens* (Roth) Corn.	..	Kankavali
F. microcarpa Linn. f. ..	..	Deogad, Bhedshi
F. tsjakela Burm. f. ..	..	Kudal, Bhedshi
F. amplissima J. E. Sm. ..	..	Sawantwadi, Bhedshi.
F. religiosa Linn. ..	..	Kankavali, Kudal
Artocarpus incisa Linn. f. ..	..	Sawantwadi, Bhedshi.
Casuarinaceae :		
Casuarina equisetifolia J. R. and G. Forst.	..	Deogad.
MONOCOTYLEDONS		
Hydrocharitaceae		
Blyxa aubertii Rich. ..	..	Sawantwadi, Bhedshi.
B. echinosperma (C. B. Cl.) Hoot. f.	July—Oct. ..	Kankavali
B. octandra (Roxb.) Planch. ex Thw.	..	Sawantwadi
Burmanniaceae :		
Burmannia pusilla (Wall. ex Miers) Thw.	..	Vengurla, Sawantwadi.
Orchidaceae :		
Eria *dalzellii* Lindl. ..	..	Vengurla, Sawantwadi.
Cirrhopetatumfimbriatum Lindi,	..	Bhedshi
Dendrobium ovatum (Willd.) Kranz.	..	Sawantwadi
D. barbatulum Lindl. ..	..	Kankavali, Bhedshi

Name	Fl. Season	Locality
D. crepidatum Lindl. ..	..	Kudal, Bhedshi
D. lawianum Lindl. ..	..	Kudal, Bhedshi
Oberonia recurva Lindl. ..	..	Kankavali, Sawantwadi.
Cottonia peduncularis (Lindl.) Reichb.	..	Sawantwadi.
Aerides crispum Lindl. ..	..	Kudal, Bhedshi
A. maculosum Lindl. ..	..	Sawantwadi
Acampe praemorsa (Roxb.) Blatt and Mcc.	..	Kankavali, Bhedshi
Smithsonia viridiflora (Dalz.) Sald.	..	Sawantwadi, Bhedshi.
Plantanthera susannae (Linn.) Lindl.	..	Kankavali, Sawantwadi.
Habenaria heyneana Lindl. ..	..	Sawantwadi
H. diphylla Dalz. ..	..	Kankavali, Sawantwadi.
H. rariflora A. Rich. ..	..	Sawantwadi
H. longicorniculata Grah.	..	Sawantwadi
H. panchganiensis Sant and Kapad.	..	Sawantwadi.
H. marginata Coleb. ..	..	Kankavali, Sawantwadi.
Peristylus densus (Lindl.) Sant and Kapad.	..	Sawantwadi
P. stocksii (Hook. f.) Kranz.	..	Kankavali
P. plantagineus Lindl. ..	..	Kankavali, Sawantwadi.
Eulophia epidendraea (Retz.) Fisch.	..	Bhedshi
Malaxis versicolor (Lindl.) Kapad.	..	Kankavali, Sawantwadi
Zingiberaceae :		
Costus speciosus (Koen.) Sm.	..	Kankavali, Sawantwadi
Curcuma neilgherrensis Wt.	..	Kudal, Bhedshi
C pseudomontana Grah. ..	..	Kankavali, Bhedshi
C. decipiens Dalz. ..	..	Kankavali, Sawantwadi.
Globba bulbifera Roxb. ..	..	Kankavali, Bhedshi
Zingiber macrostachyum Dalz.	..	Kankavali
Alpinia nutans (L.) Roscoe ..	..	Sawantwadi
Amomum microstephanum Bak.	..	Bhedshi
Hypoxidaceae		
Hypoxis aurea Lour. ..	..	Kudal, Bhedshi
Curculigo orchioides Gaertn.	..	Sawantwadi, Bhedshi.
Amaryllidaceae :		
Crinum defixum Ker-Gawl.	..	Sawantwadi
Pancratium triflorum Roxb.	..	Bhedshi
Taccaceae :		
Tacca leontopetaloides (Linn,) O. Kuntze.	..	Kankavali, Vengurla.

Name		Fl. Season	Locality
Dioscoraceae :			
Dioscorea bulbifera Linn.	..	..	Deogad, Bhedshi
D. belophylla Voigt	..	..	Sawantwadi
D. oppositifolia Linn.	..	..	Kankavali, Bhedshi
D. pentaphylla Linn.	..	..	Kankavali, Bhedshi
Dracaenaceae :			
Dracaena terniflora Roxb.	..	..	Kudal, Bhedshi
Liliaceae :			
Asparagus racemosus Willd.		..	Kudal, Bhedshi
Gloriosa superba Linn.	..	..	Kankavali, Sawantwadi.
Iphigenia indica (L.) A. Gray ex Kunth.		..	Malwan, Sawantwadi.
Ophiopogon intermedius Don. Var. *parviflorus* Hk. f.		..	Sawantwadi
Chlorophytum orchidastrum Lind.		..	Malwan, Sawantwadi.
C. breviscapum Dalz.	..	..	Sawantwadi, Bhedshi.
Urginea indica (Roxb.) Kunth.		..	Kankavali
Smilacaceae :			
Smilax zeylanica Linn.	..	..	Kudal, Sawantwadi
Pontederiaceae :			
Monochoria vaginalis (Burm.) Presl.		..	Sawantwadi, Bhedshi.
Xyridaceae :			
Xyris pauciflora Willd.	..	..	Kankavali, Sawantwadi.
Commelinaceae :			
Amischophacelus axillaris (L.) Rao and Kamm.		..	Malwan, Deogad
Commelina diffusa Burm. f.		..	Sawantwadi.
C. hasskarlii C. B. Cl.:	..	..	Sawantwadi
C. maculata Edgw. ..	..	..	Sawantwadi
C. suffruticosa Bl. ..	..	..	Sawantwadi
C. paleata Hassk.	..	..	Deogad, Sawantwadi.
Cyanotis concanensis Hassk.		..	Sawantwadi
C. fasciculata (Heyn. ex Roth) Schult. f.		..	Deogad, Sawantwadi.
C. cristata (Linn.) D. Don.		..	Deogad, Sawantwadi.
Floscopa scandens Lour	..	..	Sawantwadi
Murdannia semeteres (Dalz.) Sant.		..	Deogad, Sawantwadi.
M. elata (Vahl) Bruckn.	..	..	Kankavali, Sawantwadi.
M. simplex (Vahl) Brenan	..	..	Kankavali, Bhedshi
M. versicolor (Dalz.) Bruckn.		..	**Kankavali, Sawantwadi.**

Name	Fl. Season	Locality
M. dimorpha (Dalz.) Bruckn.	..	Sawantwadi
M. nudiflora (L) Brenan ..	..	Kankavali, Sawantwadi.
M. vaginata (L) Bruckn. ..	..	Malwan.
M. spirata (L) Bruckn. ..	..	Kankavali, Bhedshi
Arecaceae :		
Calamus pseudotenuis Becc. ex Becc. and Hook. f.	..	Sawantwadi, Bhedshi.
Pandanaceae :		
Pandanus furcatus Roxb. ..	..	Bhedshi
Typhaceae :		
Typha angustata Bory, Chanb. et al.	..	Kankavali
Araceae :		
Cryptocoryne retrospiralis: (Roxb.) Fisch.	..	Kankavali
Theriophorum indicum (Dalz.) Engl.	..	Sawantwadi
Ariopsis peltata Nimmo ..	..	Kudal, Sawantwadi
Arisaema tortuosum (Wall.) Schott.	..	Kankavali, Bhedshi
A. neglectum Schott. ..	..	Sawantwadi
Amorphophallus campanulatus (Roxb.) Bl. ex Decaisne.	..	Kudal.
A. commutatus (Schott) Engl.	..	Kudal, Sawantwadi
Remusatia vivipara (Roxb.) Schott.	..	Sawantwadi
Pothos scandens Linn. ..	..	Sawantwadi, Bhedshi.
Colocasia esculenta (Linn.) Schott	..	Kankavali
Alismataceae :		
Wiesneria triandra (Dalz.) Michel.	..	Deogad, Malwan
Eriocaulaceae :		
Eriocaulon dalzellii Koern.	..	Malwan, Sawantwadi.
E. xeranthemum Mart. ..	..	Kankavali, Sawantwadi.
E. stellulatum Koern. ..	..	Sawantwadi
E. cinereum R. Br.	..	Kankavali, Malwan
E. eleanorae Fyson	..	Sawantwadi
E. quinquangulare Linn. ..	..	Kudal.
E. dianae Fyson var. *longibracteatum* Fyson.	..	Kankavali, Sawantwadi.
E. lanceolatum Miq. ..	..	Kankavali, Malwan
E. wightianum Mart. ..	..	Sawantwadi
E. thomasi Fyson	..	Kankavali, Sawantwadi.
E. sedgwickii Fyson ..	..	Sawantwadi

Name	Fl. Season	Locality
E. odoratum Dalz. ..	..	Deogad, Sawantwadi.
E. cuspidetum Dalz. ..	..	Deogad, Malwan
E. sexangulare Linn. ..	..	Kudal
E. dianae Fyson	..	Kankavali, Bhedshi
E. robusto-brownianum Ruhl.	..	Sawantwadi
Cyperaceae :		
Scleria lithosperma (L.) Sw.	..	Sawantwadi
S. levis Retz.	..	Swantwadi, Bhedshi.
S. terrestris (Linn.) Fass. ..	..	Sawantwadi
Carex filicina Nees var. *glaucina* (Boeck.) Kuck.	..	Kankavali
Eleocharis retroflexa (Poir.) Urb.	..	Sawantwadi, Bhedshi.
E. geniculata (L.) R. and S.	..	Kudal
Rhynchospora wightiana (Nees) Stud.	..	Kudal, Sawantwadi
Scirpus articulatus Linn. ..	..	Kankavali, Sawantwadi.
S. juncoides Roxb. ..	..	Kudal
S. lateriflorus Gmel. ..	..	Deogad, Sawantwadi.
Fuirena ciliaris (L.) Roxb.	..	Kudal, Bhedshi
F. uncinata Kunth. ..	..	Kudal
Fimbristylis schoenoides (Retz.) Vahl.	..	Kankavali
F. acuminata Vahl ..	..	Kankavali, Sawantwadi.
F. tetragona R. Br. ..	..	Kankavali, Kudal
F. littoralis Gaud. ..	..	Kankavali, Bhedshi.
F. woodrowii C. B. Cl. ..	..	Kankavali
F. ferruginea (L.) Vahl ..	..	Kankavali, Sawantwadi.
F. dichotoma (L.) Vahl ..	..	Kankavali, Sawantwadi.
F. cymosa R. Br.	..	Malwan
F. argentea (Rottb.) Vahl ..	..	Sawantwadi
F. aestivalvis (Retz.) Vahl ..	..	Malwan, Bhedshi
Cyperus kyllinga Endl. ..	..	Sawantwadi
C. leucocephalus Retz. ..	..	Kankavali, Sawantwadi.
C. brevifolius (Rottb.) Hassk.	..	Kudal, Sawantwadi
C. arenarius Retz. ..	..	Deogad
C. maderaspatanus Willd. ..	..	Malwan, Sawantwadi.
C. paniceus (Rottb.) Boeck.	..	Malwan, Sawantwadi.
C. javanicus Houtt. ..	..	Kudal
C. pangorie Rottb. ..	..	Kankavali, Bhedshi
C. exaltatus Retz. ..	..	Sawantwadi
C. rotundus Linn. ..	..	Bhedshi
C. distans Linn. f. ..	..	Kankavali, Sawantwadi.

Name	Fl. Season	Locality
C. iria Linn.	..	Deogad, Sawantwadi
C. alulatus Kern.	..	Malwan
C. compactus Retz.	..	Kudal
C. squrrosus Linn.	..	Deogad
C. halpan Linn.	..	Kudal, Bhedshi
C. tenuispica Steud	..	Kankavali, Bhedshi
C. pumilus Linn.	..	Kankavali, Bhedshi
C. sanguinolentus Vahl.	..	Kankavali
C. diaphanus Schrad ex Roem	..	Sawantwadi

poaceae :

Name	Fl. Season	Locality
Dendrocalamus strictus (Roxb.) Nees.	..	Kankavali, Bhedshi
Bambusa arundinacea (Retz.) Roxb.	..	Sawantwadi, Bhedshi.
Coix lachryma-jobi Linn.	..	Kankavali, Bhedshi
Spinifex littorens (Burm. f.) Merr.	..	Malwan
Dimeria blatteri Bor	..	Sawantwadi
D. santapaui Alm.	..	Malwan
D. woodrowii Stapf.	..	Deogad, Malwan
D. stapfiana C. E. Hubb. ex Pilg.	..	Kankavali, Bhedshi
D. gracilis Nees ex Steud.	..	Kankavali, Bhedshi
D. hohenackeri Hochst. ex Miq.	..	Kankavali, Bhedshi
D. ornithopoda Trin.	..	Kankavali
Pogonachne racemosa Bor	..	Kankavali
Spodiopogon rhizophorus (Steud.) Pilg.	..	Kankavali, Sawantwadi.
Saccharum spontaneum Linn.	..	Kankavali, Bhedshi
Eulaila fimbriata (Hack.) O. Kuntze.	..	Kankavali
E. trispicata (Schult.) Henr.	..	Sawantwadi, Kankavali.
Hackelochloa granularis (L.) O. Kuntze.	..	Deogad
Manisuris clarkei Bor apud. Sant.	..	Kankavali
M. ratnagirica Kul. and Hem.	..	Sawantwadi
M. forficulata fisher	..	Kankavali, Bhedshi
M. mysorensis Jain and Hem.	..	Sawantwadi
M. santapaui Jain and Desh.	..	Deogad, Malwan
M. goaensis Rao. and Hem.	..	Bhedshi
M. acuminata (Hack.) O. Kuntze.	..	Deogad, Bhedshi
M. acuminata var. *woodrowii* Bor.	..	Bhedshi
M. acuminata var. *stocksii* (H. k. f.) Jain.	..	Kankavali, Malwan
Ischaemum indicum (Houti.) Merr.	..	Kankavali, Bhedshi
I. timorense Kunth	..	Kankavali, Bhedshi
I. commutatum Hack.	..	Kudal, Sawantwadi
I. razadae Bill. and Hem.	..	Sawantwadi

Name	Fl. Season	Locality
I. impressum Hack. ..	..	Sawantwadi
I. mangaluricum (Hack.) Stap. f. ex Fisch.	..	Kudal, Bhedshi
I. santapaui Bor	..	Kankavali, Kudal
I. travancorense Stap. f. ex Fisch.	..	Kudal, Sawantwadi
I. tumidum Stapf ex Bor ..	..	Kankavali, Bhedshi
I. dalzellii Stapf ex Bor ..	..	Kankavali, Bhedshi
I. semisagittatum Roxb. ..	..	Bhedshi
Apluda mutica Linn. ..	..	Kankavali, Sawantwadi.
Chrysopogon aciculatus (Retz.) Trin.	..	Kankavali, Sawantwadi.
C. orientalis (Desv.) A. Camus	..	Sawantwadi
C. fulvus (Spreng.) Chiov.	..	Bhedshi
Arthraxon jubatus Hack. ..	..	Sawantwadi
A. lancifolius (Trin.) Hochst.	..	Kankavali, Sawantwadi.
A. lancifolius var. *hindustanicus*. Jain and Desh. ..	..	Malwan, Bhedshi
A. nudus (Steud.) Hochst. ..	..	Malwan, Sawantwadi.
A. raizadae Jain, Hem. and Desh.	..	Malwan, Sawantwadi.
A. prinoides (Steud.) Dan.	..	Malwan, Sawantwadi.
A. meeboldii Stapf. ..	..	Konkan
Capillipedium assimile (Steud.) A. Cammus	..	Konkan
C. filiculme (Hook. f.) Stapf.	..	Konkan
Dichanthium annulatm (Forssk.) Stapf.	..	Malwan
D. caricosum (L.) A. Camus.	..	Kankavali
Schizachyrium paranjpyeanum (Bhide) Raiz. and Jain.	..	Sawantwadi
Bhidea burnsiana Bor ..	..	Malwan
Themeda triandra Forsk. ..	..	Kankavali, Bhedshi
T. quadrivalvis (Linn.) O. Kuntze.	..	Kankavali, Bhedshi
T. tremula (Nees ex Stend) Hack.	..	Kankavali, Sawantwadi.
Heteropogon contortus (L.) Beauv.	..	Deogad, Bhedshi
Pseudodichanthium serrafalcoides (Cooke ex Stapf.) Bor	..	Sawantwadi
Panicum trypheron Schult.	..	Sawantwadi
P. paludos Roxb. ..	..	Deogad, Sawantwadi.
P. repens Linn.	..	Kankavali
P. sumatrense Roth ex R. and S.	..	Sawantwadi
P. psilopodium Trin. ..	..	Kankavali, Malwan
P. notatum Retz. ..	..	Kankavali, Sawantwadi.
Cyrotococcum trigonum (Retz.) A. Camus.	..	Sawantwadi, Bhedshi.

Name	Fl. Season	Locality
C. oxyphyllum (Steud) Stapf.	..	Kankavali, Sawantwadi.
Sacciolepis interrupta (Willd.) Stapf.	..	Sawantwadi
S. myosuriodes (R. Br.) A. Camus.	..	Bhedshi
Setaria glauca (L.) Beauv.	..	Kankavali, Bhedshi
S. italica (L.) Beauv. ..	..	Kudal
Echinochloa colonum (L.) Link.	..	Kankavali, Bhedshi
E. frumentacea Link ..	..	Deogad, Malwan
Opliamenus burmannii (Retz.) P. Beauv.	..	Kankavali, Bhedshi
O. compositus (L.) Beauv.	..	Kankavali, Sawantwadi.
Paspalidium geminatum (Forssk.) Stapf.	..	Deogad
Paspalum compactum Roth ..	..	Sawantwadi
P. scrobiculatum Linn. ..	..	Kankavali
Brachiaria ramosa (L.) Stapf.	..	Kankavali
Digitaria stricta Roth ex R. and S.	..	Kankavali, Bhedshi
D. abludens (R. and S.) Veldk.	..	Deogad
D. ciliaris (Retz.) Koel. ..	..	Malwan, Bhedshi
Alloteropsis cimicina (L.) Stapf.	..	Kudal
Pseudoraphis spinescens (R. Bri) Vick.	..	Deogad
Centotheca lappacea (L.) Desv.	..	Malwan
Eragrotis japonica (Thunb.) Trin.	..	Bhedshi
E. diarrhena (Schult.) Steud.	..	Kudal
E. gangetica (Roxb.) Steud.	..	Kankavali, Bhedshi
E. poaeoides P. Beauv. ..	..	Kankavali, Bhedshi
E. unioloides (Retz.) Nees ex Steud.	..	Kankavali, Sawantwadi.
E. tremula Hochst. ex Steud.	..	Malwan
Elytrophorus spicatus (Willd.) Camus.	..	Bhedshi
Eleusine indica (L.) Gaertn.	..	Malwan.
E. Coracana (L.) Gaertn. ..	..	Kankavali
Dactyloctenium aegyptium (L.) Beauv.	..	Sawantwadi, Bhedshi.
Oropteium villosulum Stapfet Bor.	..	Deogad, Malwan
Chloris montana Roxb. ..	..	Malwan
Danthonidium gammei Bhide Jaub.	..	Sawantwadi
Oryza sativa Linn. ..	..	Kankavali, Sawantwadi.
Isachne globosa (Thunb.) O. Kuntze.	..	Deogad, Sawantwadi.
Coelachne simpliciuscula (W. and A.) Munro ex Bth.	..	Sawantwadi
C. perpusilla (Arn. ex Steud.) Thw.	..	Sawantwadi

Name	Fl. Season	Locality
Arundinella leptocheoa (Nees ex Stend) Hook. f.	..	Kankavali, Bhedshi
A. pumila (Hochst.) Stend.	..	Kankavali
A. nepalensis Trin. ..	..	Kankavali
A. metzii Hochst. Mig. ..	..	Kankavali, Sawantwadi.
Jansenella griffithiana (C. Muell) Bar.	..	Kankavali, Bhedshi
Garnotia tenella (Arn. ex. Mig.) Janowskn.	..	Sawantwadi
Sporobolus piliferus (Trin.) Kunth.	..	Sawantwadi
S. virginicus (L.) Kunth.	..	Malwan
Aristida adscensionis Linn.	..	Malwan
A. redacta Stapf. ..	..	Kankavali
A. setacea Retz.	..	Kankavali, Bhedshi
Zoysia matrella (L.) Merr.	..	Malwan
Perotis indica (L.) O. Kuntze	..	Malwan
Indopoa paupercula (Stapf.) Bor.	..	Kankavali, Sawantwadi.
Tripogon capillatus Jaub. ex Spach.	..	Sawantwadi
T. lisboae Stapf.	..	Kankavali, Sawantwadi.

11·2. Hot Water Springs of Ratnagiri :

Hot water springs are seen at several places in Ratnagiri district around Sangameshwar and at Chiplun, Khed, Unhala, Aravali, Tural, Rajawadi and Rajapur. Most of them give out bubbles containing CO_2 and H_2S, their temperature ranges from 35.5°C to 69°C. The flow of water is maximum, 1870 gallons per hour in Rajawadi springs, but only 240 gallons per hour in Khed springs. The Rajapur springs are near Unhala village. Their temperature is 42°C. None of these and other minor ones have been botanically surveyed. Of these the hot water springs at Unhala having a temperature of 69°C have radons m. Mc. 0.806 per litre of water. This spring has the largest flow of water 1500 gallons per hour. Other springs are not reported to have radons.

The water of these hot springs is supposed to cure rheumatic pains and skin diseases.

11·3. Mangroves of Ratnagiri and Sindhudurg Districts .

A unique feature of Konkan vegetation and flora is mangroves. They comprise plants growing in marine saline mud flats or in semi-muddy situations of estuaries along the west coast of India touching the Arabian sea. They extend from Malaya, Burma, Chittagong, Calcutta to Kakinada, Madras, Kerala, through Goa and Karwar to Konkan, Bombay and Saurashtra coast. Similar mangroves are seen in other parts of the world in the Eastern Tropics, upto Australia, but their highest concentration is in Malaya, and next to that in India. A few occur on African and on Australian coast. Broadly speaking they are the plants of Eastern Tropics not found in temperate countries. They have special features of their own ; for example, they seem to be lush green always, although they grow in situations which are physiologically dry. This is because they grow in places where humidity is very high throughout the year along the coast and estuaries of rivers penetrating in the interior.

In Maharashtra they extend from Terekhol river to Ratnagiri, from Bombay to Par river separating South Gujarat from Maharashtra. There are in all about 12 mangroves in Maharashtra, particularly on the Konkan coast. Table 11·4 gives the mangroves of Ratnagiri and other Konkan areas.

A number of botanists have studied them and their biology (Cooke, 1903 ; Blatter, 1905 ; Bharucha and Karnik, 1960 ; Navalkar, 1966-67). Some mangroves have stilt roots e. g. *Rhizophora mucronata* (For detailed review *see* Joshi *et al.* 1975, Blasco 1977). Some grow rooted in saline mud. They are washed by sea water twice a day. Their leaves are green and fleshy. Mullan (1931) examined their anatomy and found that they have distinct water storage devices. The osmotic pressure in their root and leaf cells is higher. Some of them use quite an amount of water despite unavailability of fresh water. How this happens and why do they not get desiccated was a problem that took nearly 40 years to get solved. Dr. G. V. Joshi (1973) worked on their mineral absorption, salt resistance and photosynthesis. He found that they all are not equally salt tolerant, but that they absorb it selectively and have different ways of retaining or excreting or balancing excess of salt. There are three categories in them : (i) Salt excluding mangroves : *Rhizophora mucronata, Ceriops tagal, Bruguiera gymnorhiza, Candalia candel.* These plants exclude salt in their absorption. (2) Salt excreting mangroves : *Avicennia officinalis, A. alba, Acanthus ilicifolius.* (3) Salt accumulating mangroves : These absorb salt (NaCl) but balance it by absorbing ions of other elements such as Potassium or Calcium e. g. *Sonneratia acida, S. apetala, Lumnitzera racemosa, Excoecaria agallocha.*

Here the functioning of cell membranes plays an important part in salt absorption and salt excretion. Their photosynthesis also has a number of peculiarities ; one is that the sodium chloride interferes with the photosynthesis process. The soils here have due proportion of potassium and calcium, but excessive calcium very often tends to inhibit growth and absorption of other constituents. As a matter of fact salt logged soils absorb more of calcium and excessive sodium chloride invariably. This process leads to more calcium being absorbed as in the Chopan soils along the Deccan canal in Sholapur, Baramati and other places in Maharashtra, and in Ussar soils in Uttar Pradesh. We have already seen that sodiumization is preliminary to calcification of soils, thereby rendering them infertile. In some mangroves there is dual mechanism for photosynthesis, C_3 and C_4.

Generally in rainy season salts in these soils get leached out and they become better. In other soils there is intake of fresh water due to rivers flowing through them to sea. However there is heavy evaporation in summer months and salt accumulates again, and the soils become rich in salt. *Rhizophora mucronata* grows in sea water containing the highest concentration of salts, whereas *Sonneratia* and *Excoecaria agallocha* grow in water with the lowest salt content, usually on the banks of rivers joining sea, where salt is the least. Still further away from the marine coast, in areas where there is a continuous influx of fresh water, plants of *Acanthus ilicifolius, Tylophora dalzellii,* grow. Some *Cyperus* and grasses like *Alepecoros* also grow. They are least tolerant of salt ; practically they are the dwellers of fresh water marshes behind the mangrove vegetation.

Thus one sees zonation in mangrove vegetation in salt rich areas on Terekhol and in less salty areas like Chiplun on the banks of Vashishthi river. The salt is less here due to influx of fresh water and less dominance

of other mangroves. The analysis of sea water and its principal mineral constituents is given elsewhere. The mangrove soils have higher percentage of salt than sea water. The salt tolerance develops slowly. Excepting *Avicennia alba*, other mangroves do not have salt glands on their leaves. Therefore, they have to adopt different mechanisms for the retention of water.

The third important feature of mangroves is vivipary. This is very nicely seen in *Rhizophora mucronata* which forms fruits on the plant and seeds germinate on tree sending down long stout radicle a part of which is retained by the fleshy fruits. *Bruguiera gymnorhiza* has also viviparous fruits. A number of lenticels develop on the radicle before the fruit is separated from the parent plant and starts germinating in mud as an independent plant. It slowly develops salt tolerance. It is not a property *ab initio* but is acquired secondarily till they are able to withstand rich salt content in soils. The embryo of *Avicennia* has no long radicle ; the embryo with a large cotyledon is released from fruit and falls on the soil near the salt marshes or rocky coastal puddles and germinates there. Secondly its leaves have water glands on them and result in high rate of respiration. Some mangroves such as *Avicennia officinalis*, and *A. alba* develop woody pneumatophores which come above the surface of the soil and help in breathing. They are seen around the plant in mud. Some of them have regular form, and others are twisted. But they all are apogeotropic. A few form even the knees e. g. Marsh Cypers or *Podocarpus*. But these two mangroves do not occur on our coasts.

The fourth important character of mangroves is the higher number of stomata on leaves per mm² as compared to those of succulents like *Aloe* (20), *Calanchoe* (32-40), *Portulaca* (48---89), on the upper and the lower surface of leaf. Of these *Kalanchoe* and *Aloe* are Crassulacean succulents. Another characteristic feature of all mangroves is that their stomata remain open during early hours of the day and close with increase in the intensity of sunlight after dawn. They also open slightly in the evening. This suggests that the maximum photosynthetic assimilation in mangroves takes place between 8 a.m. and 10 a.m. At high temperature since the stomata close down, carbon assimilation in them at noon, is not possible. Salt tolerance is also developed by marine algae like *Cladophora, Ulva, Sargassum* and by animals like Crustacea.

With all these adaptations mangroves seem to be not only dominating plants along sea coast, but they seem to thrive, and keep green our coast line. In all there are about 30—50 such plants world over, and about 25 in India. A huge proportion of them is seen in the Sunderbuns at the mouth of Hoogli river. Two special mangroves are *Heretiera maritima* or *Sundari* and *Nypa fruticans* the floating palm of marshy areas along the sea coast. Another palm that occurs there is not strictly a mangrove or a dweller of heavy salt laiden areas, *Phoenix paludosa.* Both these palms do not occur in Konkan area, but are plentiful in Sri Lanka, Calcutta, Rangoon, etc.

On Konkan coast very few marine grasses are present,but at Vengurla, Malwan many are present. There is also found a marine grass *Anhalus maritima*. The sea shore here is extremely rocky and forms ponds. At Kakinada on the East coast in Andra Pradesh, the number of mangroves is less than in Konkan, but the relative proportion of plants f a species is more.

Mangroves are economically important as their bark is a rich source of tannin for which they are much prized. At Madras and other places there is a great demand for their bark by tanners. They also prevent soil erosion. They are an edaphic climax plant community.

The Konkan coast all along is neither rocky nor sandy like the Madras coast. It is both sandy and rocky. Behind the rocks on sands there is another plant community the sand binders. In the depressions in rocks along the sea coast, soil gets accumulated and on it the strand plants grow. Sometimes in such soils at some places salt accumulates and the land becomes unfertile. Such soils are called Khar lands. They occupy pretty large disconnected areas from Sawantwadi to Surat and even on Saurashtra coast. Government is trying to reclaim the Khar lands with a view to increase cultivation.

11·4. DISTRIBUTION OF MANGROVES IN RATNAGIRI AND OTHER KONKAN AREAS

Serial No.	Name	Relative, dominance at		Inorganic constituents of mangroves at Chiplun (Vashisthi)					Terekhol				
		Chiplun (Vashisthi)	Terekhal	Na	K	Ca	Cl	Nak	Na	K	Ca	Cl	Nak
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Sonneratiaceae :												
1	*Sonneratia acida*	Rare	Common	0·96	0·92	1·18	2·04	1·1	2·04	1·44	1·56	4·12	1·4
2	*Sonneratia apetala*	Dominant patches.	Rare	..	..	..	..	..	..	..	..	..	..
	Rhizophoraceae :												
3	*Rhizophora mucronata*	Common	Dominant	1·6	0·48	0·75	2·9	3·3	2·44	0·76	1·14	4·41	3·2
4	*Kandelia rheedei*	Less Common	Less Common	0·72	1·24	0·85	2·27	0·6	2·0	0·84	0·68	2·84	2·4
	Myrsinaceae :												
5	*Aeguiceras majus*	Common	Common	0·48	0·4	0·27	0·71	1·2	1·72	0·9	0·5	2·27	1·9
	Berbenaceae :												
6	*Avicennia alba*	Rare	Dominant and pure patches.	..	..	..	..	..	..	..	..	..	..
7	*Avicennia officinalis*	Common	Common	1·6	1·08	0·44	2·12	1·5	2·76	1·12	0·84	3·2	2·5
	Acanthaceae :												
8	*Acanthus ilicifolius*	Dominant	Common	0·68	2·4	1·28	3·33	0·3	2·68	1·64	1·12	5·11	1·6
	Euphorbiaceae :												
9	*Excoecaria agallocha*	Common	Very common	0·3	0·52	1·8	0·57	0·2	0·8	1·9	1·72	2·56	0·4
	Papilionaceae :												
10	*Derris uliginosa*	Rare	Rare	..	..	..	..	..	..	..	..	..	..

N. B.—It will be seen that the different mangroves have different proportion of inorganic ions, and different distribution depending on their salt clearance.

11 5 Strand Plants :

Principal forests in Konkan are along the lower slopes of hills, before the plain begins and behind the littoral swamps and sands near the coast line. Behind them and along the banks of rivers joining the creeks they occur. At high tide mark some plants are daily inundated by sea water and some only twice in a month when high tide incurs far behind the sea coast line. Behind these the soil is collected in the depressions of creeks. Thick strands of trees form a continuous belt of vegetation behind the mangroves in a number of places. As we go farther towards interior there are trees forming discontinuous canopy. At the fringe of the forests there are shrubs and under-shrubs. The sea coast however is sometimes interrupted by Sahyadri ranges reaching right upto and inside sea as, at Jawhar, Alibag or Terekhol. But generally there are littoral swamps behind the rocky sea shore or sands.

Mangroves grow here. At other places the seashore is sandy and forms long stretches of sandy belts as at Dahanu, Ratnagiri or Karwar. At Saviku near Chiplun there are sand bars but all places near Terekhol river are getting silted up. Here we get strands of *Casuarina* or *Calophyllum inophyllum*. At places there is a regular mixed forest having some woody creepers on trees such as *Barringtonia speciosa* and *Barringtonia acutangula*, *Calophyllum inophyllum*, *Thespecia populnea* mixed with *Lumnitzera racemosa and Sonneratia acida*. Some grasses and hedges, *Derris uliginosa, Combretum ovalifolium, Caesalpinia nuga, Dalbergia spinosa, Xylocarpus obovatus, Pandanus furcatus, Pandanus odoratissimus, Gnetum ula* are found. If the soil collected is not washed away, a regular small belt of forest is developed behind the mud flats as at Ratnagiri or Ghod Bunder.

On the banks of rivers mangroves and seashore plants get salted out in zones according to the proportion of salt present in the mud, banks of rivers, creeks and salt tolerance of the species.

In some places there is always intake of fresh water and species which are not tolerant of strong saline conditions. Their plants become succulent. Some of them are never to be seen in places where sea water is rich in salt content and inundates them. So they are away from sea coast. e. g. *Acanthus ilicifolius, Tylophora dalzellii, Aloe barbadense, Asparagus racemosus*. These are typical plants behind the mangroves *Sonneratia apetela, Sonneratia acida, Avicennia officinalis*. In the fore-ground of them grow *Exoaecaria agallocha, Avicennia officinalis, Carapa obovata*. As the summer proceeds the proportion of salt content in the wet mud increases and by that time the plants therein get adapted and develop tolerance to higher percentage of salt. Here on the fringe one notices *Salvadora persoca*, grasses like *Spinifex squarrosus*, and *Clerodendron inerme*. In such situations even these plant species show succulence.

Where the fresh water percolates more we get forest tracts having *Sterculia guttata, Erythrina sp. Dalbergia latifolia, Bauhinia malabarica* etc.

Where the sea is sandy or rocky, and not muddy, there are a number of sand binders *Ipomoea biloba, Suaeda maritima, Spinifex squamosus, Pandanus odoratissmus, Cressa cretica, Portulaca oleracea, Launea nudicaulis, Lepidagathis cristata, Pedalium murex, Sida veronicifolia, Sesuvium protulocastrum, Erythrina stricta, Orthocnemum indicum, Sporobolus glaucifolius, Salicornea bracheata* and other species.

The most tolerant of high percentage of salt in saline situations is *Rhizophora mucronata*, and where it is the least *Sonneratia apetala, Acanthus ilicifolius, Excoecaria agallocha* grow and occasionally *Kandielia candel*. On the Bombay coast *Avicennia alba* is dominant and occurs in pure stretches. The other species *Avicennia officinalis* or *A. maring* is common elsewhere. Some mangroves can also grow in fresh water e. g., *Acanthus ilicifolius*.

12. FLORA OF KANKAVALI

Kankavali is a taluka place about 40 kilometres to the east of Malvan having an old temple of Kanakeshwar on a range of Sahyadri. Being on a hillock, it has equable climate throughout the year. It receives about 2286—2540 mm. rain every year, a little more than Bombay. The number of rainy days is 100, from 2nd week of June to end of September. The soil is mostly lateritic, rather poor in Nitrogen. There is good forest as the hill above the Konkan plain, but the growth of trees in spite of the continuous humidity is not much. Teak (*Tectona grandis*) forms forest rather of a poor type. *Bambusa arundanesia, Dillenia pentacyna, Terminalia chebula, T. cranulata, T. bellirica, Legerstroemia* sp. *Mangifera indica, Saraca indica, Bauhinia vahlii, Vitis woodrowii, Holarrhena antidysenterica* are the chief constituents. Among the bushes prominent are *Capparis sepiaria, Barleria courtallica, Sida rhombifolia, Euphorbia ligularia, Ixora coccinea.*

The flora is a mixture of moist deciduous and dry deciduous types. It was worked out by A. N. Namjoshi and Dr. B. G. Kulkarni. It is given by Ezakiel (1947). The plants of the main areas are noted below.

Plants of Kankavali Hills :

The flora of Kankavali hills is concentrated in six localities all around the temple of Kanakeshwar, *viz*. (*i*) plants in the vicinity of the Kanakeshwar Temple proper, (*ii*) around Kaivalyadham, (*iii*) on western slopes, (*iv*) on north-western slopes, (*v*) Danda area, and (*vi*) Vyagreshwar Plateau. 80 per cent of flora has been covered and enlisted by A. N. Namjoshi and given by M. Ezakiel (1947).

The most dominant plants forming upper canopy are *Mangifera indica, Saraca indica, Bauhinia vahlii.* The second story is formed by *Calophyllum inophyllum, Terminalia chebula, T. bellerica.* On Vyagreshwar side one notices *Alseodaphne semicarpifolia, Erythrina indica, Anodendron paniculatum, Gnetum ula* (*G. Scandans*) is abundant in Danda area which also contains other woody creepers. This suggests moist deciduous forest. On the other hand, on the north-western slopes one notices *Euphorbia ligularia* as the dominant bush. Near the temple itself, there is good vegetation consisting of about 125 species. Among them *Anacardium occidentale, Anogeissus latifolia* are very prominent and abundant. A number of shrubs like those of *Memecylon umbellatum* form the second layer. On the ground there are several members of Acanthaeceae, Compositae, tuberous monocotyledons. *Carissa carandas* (=*C-Congesta*). *Calicopteris floribunda* occur at the fringe of the forest. During the rainy season grasses and bulberous lilies and two ferns *Adiantum lunulatum* and *Athyrium hohenakaryanum* grow in sandy places. The vegetation thus seems to be of moist deciduous type in certain areas on north-western slopes and of deciduous woodland type in others. This is largely due to the soil being washed away by heavy rains on hill slopes. Moist species grow on soils where debris is gathered in valleys. Among the important plants noteworthy are

Terminalia arjuna, *Acacia catechu*, *A. concinna*, *Pterospermum acerifolium*, *Holarrhena antidysenteriea.* Around Kaivalyadham Ashram, *Saraca indica*, *Sterculia colorata*, *Ficus heterophylla*, *Ixora concinna* are seen. On the western slopes, *Eugenia jambolana*, *Vitis woodrowii*, *Alysicarpus vaginalis*, *Pavatta indica* are dominant. On the western slopes *Euphorbia ligularia*, *Calycopteris floribunda*, *Alysicarpus vaginalis* are abundant. On the northern slopes and in Danda area there are many creepers like *Symphorema involucrata*, *Capparis horrida*, *Smilax macrophylla*, *Cansjera rheedii*, *Vitis repanda*. *Terminalia bellerica*, *T. chebula* and *Dillenia pentagyna*, *Ochrocarpus longifolius*, *Sterculia guttata*, *Garuga pinnata*, *Pterocarpus acerifolium* seem to be dominant. Species of *Bridelia*, *Zizyphus* and *Leea microphylla* are dominant. On north-western slopes there is not much soil and only tuberous plants like *Curculigo orchioides*, *Chlorophytum tuberosum* and parasitic *Aeginetia indica* grow on a number of shrubs. Considered as a whole the flora of Kanakeshwar despite high humidity is a thorn savannah on the slope of hills and of moist deciduous type in the valleys on western slopes.

13. Islands in Arabian Sea along the coast of Konkan

There are more than 100 islands in Arabian sea all along the west coast of India, lying at a variable distance off the coast. They are also of variable size. They are important from the view points of coastal defences, oil and gas resources, commerce and sea traffic. They occur in two sub-groups :—

(*A*) Bombay sub-group consisting of 7 islands.

(*B*) Malvan sub-group of 6 islands.

(*A*) *The Bombay sub-group* (18°55′N., 72°.54′E.)—

(1) Elephanta island or Gharapuri.
(2) Butcher's island.
(3) Armoury island.
(4) Nhava island.
(5) Sheva island.
(6) Manori island.
(7) Madh island.

(*B*) Malvan sub-group (16°.3′N, 73°.28′E)—

(1) Kawade Bakal.
(2) Devatara.
(3) Padmagad.
(4) Sindhudurg.
(5) Vengurla oyster rocks.
(6) Redi Fort Basin Islet.

Of these the plants of Elephanta have been recently surveyed by Dr. A. C. Untawale of National Oceanographic Institute, Goa.

Those of Madh Island had been earlier collected by Dr. G. L. Shah (1965) and by Dr. Untawale recently. He has also surveyed the islands along the coast of Gujerat, Saurashtra, Goa and Malabar.

The flora of these islands except those along the Saurashtra coast is in no way different from that on the mainland of Maharashtra facing opposite them. It is not endemic or insular. The flora is of the monsoon dry deciduous type. They are fringed or encircled by mangrove vegetation which is the same as on the west coast of India having sticky mud flats around. A detailed investigation of these islands was made under Dr. T. S. Mahabale and Dr. Untawale as a special project of the Indian National Science Academy, Delhi at the National Oceanographic Institute, Mira Mar, Goa. But their report is not yet published which might throw further light on the flora and fauna of them. One thing which appears to be certain is that they appear to have been separated from the mainland at no very distant past and have similar flora as is on the opposite mainland. Such is not the case with the islands opposite Saurashtra Coast, e. g. Piram Island.

Plants of Elephanta are already described previously and those of Malvan group are described under :—

13·1. Plants of Bakal Kauda Island near Malvan (also known as *Kawade Bakal*):

Papilionaceae :
Phaseolus radiatus L.

Cucurbitaceae :
Luffa acutangula Roxb.

Compositae :
Tricholepis glabarrina DC.
Sphaeranthus africanus L.

Amarantaceae :
Aerua sanguinolanta (L.) Bl.
Celosia argentea L.

Gramineae :
Ischaemum cupressum

Cyperaceae :
Cyperus rotundus L.
Fimbristylis ferruginea (L.) Vahl.

13·2. Plants within the Sea Fort Sindhudurg near Malvan :

This is a very important well known sea fort, standing on a solid rock off the Malvan coast. The plants within its walls are given below :—

Capparidaceae :
Capparis zeylanica L.
Capparia hanida.

Portulacaceae :
Portulaca oleracea L.

Elatinaceae :
Garmis ammanioides Roxb.

Malvaceae :
Abutilon indicum (L.) Sw.
Urena lobata L.

Sida cordata (Burm. f.) Borss.
—*Sida vernonicifolia* Burm.

Papilionaceae
Indigofera cordifolia Hayne ex Roth.
Alysicarpus procumbens (Roxb.) Schindl.
Alysicarpus glumaceus (Vahl) DC.
Zornia diphylla (L.) Pers.
Desmodium triflorum (L.) DC.
Vigna radiata L.
Phaseolus radiatus L.

Caesalpinaceae
Cassia pumila L.
Cassia absus L.
Cassia tora L.

Lythraceae :
Ammania multiflora Roxb.

Rubiaceae :
Oldenlandia herbacea DC.

Compositae :
Vernonia cinerea (L.) Less.
Ageratum conyzoides L.
Synedrella nodiflora (L.) Gaertn.
Eclipta alba Hassk.
—*Eclipta prostrata* L.
Tridax procumbens L.
Centratherum minuticum.
Launea pinnatifida Cass.

Gentianaceae :
Hoppea dichotoma Willd.

Convolvulaceae :
Ipomoea pes-tigridis L.

Scrophulariaceae :
Centranthera indica (L.) Gamble.
Centranthera hispida Br.

Pedaliaceae :
Sesamum indicum L.

Acanthaceae :
Justicia trinervia Vahl.
Achyranthus aspera L.

Labiatae :
Leucas lavendulifolia Sm.

Verbenaceae :
Vitex nigundo L. (v. *trifolia*).
Lantana camera L.

Amarantaceae :
Celosia argentia L.
Aerva lanata (L.) Juss.
Alternanthera sesslis Br.

Loranthaceae :
Viscum nepalense Spreng.
—*Viscum articulatum* Burm.

Euphorbiaceae :
Euphorbia hirta L.

Urticaceae :
Laportea interrupta (L.) Chew.
—*Fleurya interrupta* Gaud.

Commelinaceae :
Commelina benghalensis L.

Cyperaceae :
Cyperus sp.
C. pumilus L.
C. compressus L.
C. squarrosus L.
Fimbristylis argentea Vahl.

Gramineae :
Oplismenus burmannii (Retz.) Beauv.
O. compositus (L.) Beauv.
Eragrostis tenella (L.) Woodr.
E. japonica (Thunb.) Trin.
E. unioloides (Retz.) Nees ex Steud.
Heteropogon contortus (L.) Beauv.
Themeda triandra Forsk.
Ischaemum indicum Merr.
Spodiopogon rhizophorus (Steud.) Pilg.
Arthraxon lancifolius (Trin.) Hochst.
Ochlanda mutica L.
Eleusine indica (L.) Gaertn.

14. Comparison of the Flora of Konkan Districts with that of others

The soil types in Konkan are : (1) Red soils, (2) Black soils, (3) Lateritic soils, (4) Coastal alluvial soils, common in coastal areas. We shall consider first those in Thane district.

Soils in Thane district can broadly be classified into two major types, i.e., (1) Coastal saline and alluvial, (2) Red and grey soils. The latter occupy major part of the district and are grouped in three categories as, (a) coarse shallow on slopes and clayey loam in valleys, (b) medium black soils in plains and deep black soils in valleys and low lands, (c) narrow strips of reddish-brown soils on hill slopes derived from traps.

The vegetation in Thane is of dry and moist deciduous types, the latter mainly in valleys. At places along higher slopes of ghats, it tends to form semi-evergreen tracts of forest with a meagre representation of evergreen species. The forests in South Ratnagiri district and in Goa are more or less the same and show similarity except that the vegetation is evergreen in parts and is denser in Goa and North Kanara due to continuous humidity throughout the year. Thane district is drier than Ratnagiri. The following plants occur in Thane district in different forests.

(1) *Coastal tidal forests* :

They are mostly composed of small trees of *Rhizophora mucronata*, *Sonneratia caseolaris*, *S. apetala*, *Avicennia marina* var. *acutissima*, *A. officinalis*, *Bruguiera gymnorhiza*, *Ceriops tagal*, *Aegiceras corniculata* *Acanthus ilicifolius*.

(2) *Dry deciduous forests* :

These occur on plains and upper slopes of hills composed of trees and shrubs of *Acacia chundra*, *Careya arborea*, *Xerompius spinosa*, *Ixora coccinia*, *Syzygium caryophyllatum* and grasses *Digitaria ciliaris*, *Heteropogon contortus*, *Apluda mutica*.

(3) *Moist deciduous forest vegetation* :

This consists of trees *Anogeissus latifolia*, *Tectona grandis*, *Terminalia bellirica*, *T. crenulata*, *Lagerstroemia parviflora*, *Mitragyna parvifolia*, *Ficus religiosa*.

Shrubs are *Helicteres isora*, *Microcoas paniculata*, *Carissa congesta*, *Melastoma malabaricum*, *Moghania strobilifera*. Herbs consist of *Costus speciosus*. *Sida rhombifolia*, *Triumfetta rhomboidea*. *Urena lobata* and climbers *Gnetumula*, *Calycopteris floribunda*, *Diploclisia glaucescens*.

(4) *Semi-evergreen type of vegetation* :

This consists of *Mallotus philippensis*, *Memecylon umbellatum*, *Symplocos racemosus*, *Syzygiun cumini*, *Actinodaphne angustifolia*, *Olea dioica*.

Shrubs here are *Callicarpa tomentosa*, *Nilgirianthus reticulatum*, *Jasminum malabaricum*, *Murraya paniculata*, *Elaeagnus conferta*, *Capparis rotundifolia*.

(5) *Herbs* found are *Eranthemum roseum*, *Lobelia nicotianaefolia*, *Carex filicina*, *Senecio dalzellii*, *Nogra simplicifolia*, *Oplismenus burmanni*.

All these are comparable with the vegetation in South Ratnagiri area.

(1) Littoral zone. This has coastal mangrove vegetation in saline soils. This is more or less the same as in Thane and Greater Bombay districts. It is composed of *Rhizophora mucronata*, *R. conjugata*, *Sonneratia caseolaris*, *S. apetala*, *Bruguiera gymnorhiza*, *B. cylindrica*, *Kandelia candel*, *Ceriops tagal*, *Avicennia marina var acutissima*, *A. officinalis*, *Aegiceras corniculata*, *Lumnitzera racemosa*, *Excoecaria agallocha*, *Acanthus ilicifolius*. The creek vegetation is composed of *Thespesia populnea*, *Cerbera manghas*, *Erythrina orientalis*, *Canavalea rosca*, *Derris trifoliata*, *Clerodendrum inerme*.

(2) The Deciduous forest is composed of small trees and shrubs like *Acacia chundra*, *Careya arborea*, *Leea macrophylla*, *Microcos paniculata*, *Zizyphus oenoplia*, *Carissa congesta*, *Holarrhena antidysenterica*, *Lagerstroemia parviflora*, *Lannaea coromandelica*, *Flacourtia indica*, *Syzygium caryophyllatum*. *Tectona grandis*. Herbs are *Sida rhomboides*, *Crotolaria linifolia*, *C. lutescens*, *Clerodendrum serratum*, *Costus speciosus*, *Manisuris acuminata*, *M. goaensis*, *Ischaemum santapaui*, Climbers are *Dioscorea bulbifera*, *Cocculus hirsutus*. *Tinospora sinensis*. *Ampelocisus latifolia*.

The main feature of this vegetation is the deciduous nature of trees. All however do not shed leaves at one and the same time as rightly

pointed out by Santapau (1960) in his *Flora of Khandala*. Some plants shed leaves at the beginning of winter and form new foliage in spring. The vernal habit of these is clear e. g. *Tectona grandis, Xylia xylocarpa Terminalia chebula, T. crenulata, Careya arborea, Xeromphis spinosa.* Some shed leaves in the midst of rainy season e. g. *Lagerstroemia, Alstonia, Holarrhena, Wrightia* ; but they also have the habit of shedding leaves, a characteristic of deciduous plant community.

(3) Moist deciduous Forest Vegetation : This is found along ghat slopes : The composition of this is in 3 layers : *Tectona grandis, Terminalia crenulata, Syzygium cumini* are the dominant tree species. Other Sub-dominant species are *Sterculia guttata, Prunus zeylanica, Bauhinia racemosa, Atalantia racemosa, Syzygium cumini, Ficus religiosa, tetrameles nudiflora, Nothopodytes foetida.*

Shrubs are *Helicteris isora, Microcas paniculata, Meyna laxiflora, Carissa congesta, Calamus pseudotenuis, Leea indica, Allophylus cobbe, Maesa indica.*

Herbs are *Blepharis asperrima, Impatiens pulcherrima, Gynura cusimbus, Elephantopus scaber, Apluda mutica, Oplismenus burmanni, Spodiopogon rhizophorus.*

(4) Semi-evergreen forests : These occur along the middle slopes, in valleys on ghat tops and in Dev Rai. They are composed of trees *Cryptocarya wightiana, Litsea stocksii, Dysoxylum binectariferum, Holigarna grahami, Dimocarpus longum, Cassine paniculata, Beischmiedia dalzellii, Syzygium hemisphericum, Vitex altissima.*

Shrubs-Alcophila excelsa, Meiogyne pannosa, Dichopetalum gelonioides, Mallotus stenanthus, Ixora nigricans, Evonymus indicus Blachia denudata.

Herbs are *Gymnostachyum glabrum, Lepidagathis fasciculata, Epithema carnosum, Arthraxon gubatus.*

Lianas-Salacia macrosperma, Uvaria narum, Embelia sp. Narvelia zeylanica, Dioscorea belophylla.

Vegetation of Goa

Soils in Goa are mainly of three types. (1) Laterite of high and low level type formed by natural metamorphosis and degeneration of undulating rocks along ghats, (2) Red gravelly soils derived from micaceous granite gneiss, covering the undulating plateaus mixed with medium black soils adjoining river banks, and (3) Alluvial soils including coastal alluvium along the coastal belt and in low lying situations.

1. The coastal vegetation in Goa is composed of *Rhizophora mucronata, R. congugata, Sonneratia caseolaris, Avicennia marina* var. *acutissima, Excoecaria agallocha, Kandelia candel.*

The vegetation in creeks is composed of *Thespesia populnea, Pongamia innata, Cerbera manghas, Calophyllum inophylum, Derris trifoliata, Caesalpinia cristata and Wedelia biflora.*

(2) The deciduous type occurs in plains and on plateaus. It is made up of *Carissa congesta, Holarrhena antidysenterica, Lantana camara* var. *aculeata, Vitex negundo, Grewia abutilifolia, Breynia retusa, Zizyphus*

oenoplia, Ixora coccinea, Acacia chundra, Terminalia crenulata. On waste lands *Scoparia dulcis, Leonotis nepetaefolia, Borreria pusilla, Phyllanthus asperulatus* and species of *Corchorus, Sida, Lecuas, Justicia* grow profusely.

Climbers seen are *Cocculus hirsutus, Cissampelos pareira, Ampelocissus latifolia, Cissus adnata, Tinospora sinensis, Dioscorea bulbifera. Cryratia trifolia.*

In valleys there are pockets containing evergreen species.

(3) Moist deciduous forests. The important components of these deciduous forests are *Terminalia crenulata, Tibellerica Anogeissus latifolia, Xylia xylocarpa, Dalbergia latifolia, Dillenia pentagyna, Careya arborea* mixed with *Adina cordifolia, Mitragyna parvifolia, Heterophragma quadriloculare* and bamboos *Dendrocalamus strictus* and *Bambusa arundinacea.*

The top canopy is of arboreal members *Lagerstroemia microcarpa, Terminalia crenulata, Albizzia odoratissima, Xylia xylocarpa, Schleichera oleosa, Alstonia scholaris, Xeromphis spinosa, Macaranga peltata* and *Strychnos nux-vomica.* The moderately tall trees are of *Canthium dicoccum, Xantolis tomentosa, Flacourtia montana.*

The shrubby layer is made up of *Callicarpa tomentosa, Ventilago maderaspatana, Zizyphus xylopyra, Leea latifolia, L. indica, Moghania strobilifera, Clerodendrum serratum, C. viscosum.*

The ground flora comes up in forest clearings and exposed situations. It consists of *Geissaspis cristata, Crotalaria linifolia, Crotalaria nana, Desmodium gangeticum, Alysicarpus rugosus, Justicia procumbens, Themeda trementa, Heteropogon contortus.*

(4) Semi-evergreen forests are seen only in patches along the upper elevations of the ghats mostly above 500 m and bordering regions contiguous with the forests of Sindhudurg and North Canara down south. In this belt moist deciduous forests gradually change to semi-evergreen formation into isolated patches of typical evergreen species. They are seen scattered in the sheltered ravines and valleys. The tree canopy is composed of *Michelia champaca (introduced), Myristica malabarica, Cryptocarya wightiana, Actinodaphne angustifolia, Lagerstroemia microcarpa, Holigarna grahami, Sapindus laurifolius.*

Next in order come the trees of *Alseodaphne semicarpifolia, Glochidion hohenackeri, Ixora nigricans, Blachia javanica, Linociera malabarica, Olea dioica, Macaranga peltata, Hopea wightiana, Clausena dentata.* On the forest outskirts *Ligustrum perrottetii, Meyna laxiflora Gomphandra axillaris, Wendlandia thyrsoidea, Glochidion velutinum Ficus exasperata, Celtis cinnamomea, Blachia denudana* are present.

The third layer is composed of shrubs of *Chassalia ophioxyloides, Psychotria dalzellii, Maesa indica, Maytenus rothiana, Paramignya monophylla, Glycosmis mauritiana, Leea indica* and the scandent shrubs *Lavanga sarmentosa, Ancistrocladus, heyneanus, Sarcostigma kleinii, Connarus wightii, Strychnos colubrina, Salacia oblonga.* In open disturbed forest areas *Dillenia pentagyna, Careya arborea, Xeromphis spinosa* are common together with climbers such as *Argyreia involucrata, Jasminum malabaricum, Ichnocarpus frutescens, Smilax zeylanica, Mussaenda glabrata, Rubia cordifolia.*

(5) The Evergreen forest: The forests here never reach climax as they do in North Kanara in Karnatak. Their density is much less, often quite patchy due to biotic interference. The lofty trees belong to *Calophyllum elatum*, *C. apatalum*, *Garcinia cambogia*, *Canarium strictum*, *Chrysophyllum roxburghii*, *Palaquium ellipticum*, *Diospyros ebenum* and *Knema attenuata*. Medium sized trees are of *Litsea wightiana*, *L. coriacea*, *Aporosa lindleyana*, *Carallia brachiata*, *Euodia lunu-ankenda* (near streams). *Hydnocarpus laurifolia* and *Syzygium cumini* are frequent. The forests abound in lianas such as *Butea parviflora*, *Entada pursaetha*, *Schefflera venulosa*, *Chonemorpha fragrans*, *Gnetumula*, *Derris bekeri* and *Combretum latifolium*.

The undergrowth is composed of such shrubs as *Ixora coccinea* *Dracaena terniflora*, *Rauvolfia serpentina*, *Thelepaepale ixiocephala* *Mackenzia integrifolia*.

The herbaceous vegetation in these forests consists of *Geophila reniformis*, *Adenostemma lavenia*, *Costus speciosus*, *Curcuma decipiens*, *Ageratum coryzoides*, *Spilanthes paniculata*, *Habenaria marginata*, *H. heyneana*, *Geodorum densiflorum*, *Platanthera susannae* and ferns *Christella dentata*, *Pterisquadriaurita* and *Angiopteris erecta*.

VEGETATION OF NORTH KANARA DISTRICT

The district has two types of soils *viz.* black and red. Black soils support evergreen or deciduous types of vegetation depending on soil types. Red soils support evergreen and moist deciduous types of vegetation. Hard shallow soils support only scrub. Rainfall ranges up to 5000 mm per annum. The climate is typically monsoonic.

Vegetation comprises four types as follows: (1) Tidal vegetation, (2) Scrub vegetation, (3) Moist deciduous forest vegetation, and (4) evergreen vegetation.

(1) Coastal or tidal vegetation is made up of *Rhizophora mucronata*, *R. conjugata*, *Bruguiera gymnorrhiza*, *B., cylindrica*, *Kandelia candel*, *Sonneratia caseolaris*, *S. apetala*, *Ceriops tagal*, *Avicennia marina* var. *acutissima*, *Heritiera littoralis*, *Excoecaria agalloca*.

The creek vegetation consists of *Aglaia talbotii*, *Pongamia pinnata* *Derris trifoliata*, *Vitex negundo*.

(2) Scrub vegetation is composed of *Carissa congesta*, *Maytenus rothiana*, *Ixora parviflora*, *Flacourtia indica*, *Bridelia stipularis*, *Zizyphus oenoplia*, *Lagerstroemia parviflora*, *Careya arborea* in black soil. In lateritic soil scrub forest is found, made up of *Gardenia lucida*, *Ixora coccinea*, *Glochidion hohenackeri*, *Carissa congesta*, *Flacourtia montana*, *Osyris arborea*, *Canthium dicoccum*, *Terminalia chebula*, *Santalum album* (occasional). Common climbers are *Dalbergia sympathetica*, *Celastrus paniculatus*, *Jasminum malabaricum*, *Zizyphus rugosa* etc.

(3) Moist deciduous type of vegetation—This usually does not show any stratification. They have open canopy. Trees may be evergreen or deciduous attaining a height of 23 metres or so. Their composition here is as follows:—

Trees: *Grewia tiliaefolia*, *Adina cordifolia*, *Phyllanthus emblica*, *Madhuca latifolia*, *Dillenia pentagyna*, *Tectona grandis* and *Xylia Xylocarpa* mixed with bamboos *Dendrocalamus strictus* and *Bambusa arundinacea*.

The deciduous species occur mixed. They are *Terminalia tomentosa*, *Tectona grandis*, *Buchanania lanzan*, *Anogeissus latifolia*, *Lagerstroemia microcarpa*, *Grewia tiliaefolia*, *Diospyros melanoxylon*, *Dalbergia latifolia*. Other species are *Zizyphus rugosa*, *Z. oenoplia*, *Meyna laxiflora*, *Xeromphis spinosa*, *Helicteris isora*, *Acacia rugata*, *Dioscorea bulbifera*.

(4) Evergreen forests : These are found in the central uplands of the district. The forests exhibit characteristic stratification, the forest storey exceeding 50—55 m. Some of the top storey trees are *Artocarpus hirsutus*, *A. gomezianus*, *Alseodaphne semecarpifolia*, *Cinnamomum verum*, *Diospyros microphylla*, *Elaeocarpus tuberculatus*.

It will thus be seen that the vegetation of five districts of Konkan is similar in point of types, but it gradually becomes sparse northwards ; in arid areas it becomes almost scrubby in some places. It has small pockets of evergreen or semi-evergreen vegetation either in valleys rich in debris and in soil at high altitude. But in the latter case it looks as if the evergreen species are not only dwindling but even dying out. That is because of the high rainfall and complete washing and leaching of soils. Leaching of soils and their erosion are two factors which do not allow the climatic climax vegetation to come up in Konkan districts. Erosion is more where the soils are derived from sandy loam of metamorphic origin.

Flora in Sindhudurg is more similar to that of Goa and North Kanara. But is poor as compared to that in Kanara or Goa.

15. Main features of the flora of Konkan

(1) Flora of Konkan comprises about 571 species to which about 20 new species have been added during last 25 years. The number of genera and family is approximately 602 and 142, respectively.

(2) Because of humidity throughout the year, the plants in Konkan look always lush green as in Kerala.

(3) The climate is very suitable for the horticultural crops, such as mango, jute, spices, *Amsul* (*Garcinia indica*), various palms including oil palm in northern part.

(4) Essential oil yielding species thrive well in South Konkan. However, the lateritic soils are not much fertile for foodgrain crops. Rice, millets like Ragi and Rala grow, but it is more suitable for tuber crops and leafy vegetables.

(5) In the sandy soils there is a probability for growing bamboo and orchards of fruit trees. Some species grow well around Dahanu, Dapoli, Ratnagiri etc.

(6) Mangoes grow well in Ratnagiri, and are a great source of income by exporting them to Bombay and abroad. Medicinal plants grow well in Sawantwadi, Aronda and Malwan.

(7) Where the soils are alluvial or black, they produce good crop of sugarcane.

(8) Mangroves form a continuous strip along the littoral zone. In the sublittoral zone, there are forests of strand plants.

(9) The forests grow teak fairly well especially in Jawhar and Ratnagiri ranges, but it is not so good as that in Dangs (Gujarat).

(10) The mountain tops are barren, due to soil erosion by heavy rains, at places not even good grass grows. This has direct effect on the milch cattle in Konkan.

(11) There is high possibility of growing marine algae along the rocky coast especially near Malwan and Vengurla which are known to have trenches full of food material for the fishes and marine fauna.

(12) Flora of all the districts of Konkan is more or less similar qualitatively, but density and dominance of species differ.

(13) In the fort of Sindhudurg, there is a continuity of plants similar to those on the main land, although enclosed within the fort walls.

(14) At Vajreshwari, Mahad, Sangameshwar and a few other places there are hot water springs which are believed to have medicinal properties. They need full investigation.

(15) Opposite the Konkan coast there are small islands which do not contain insular flora (See the list of islands and their flora).

(16) Sea level of Ratnagiri coast seems to have been much higher in the past than what it is at present. This is indicated by leafy beds at a higher level 7 to 9 metres at Ratnagiri, Pavas and other places.

(17) Main floral elements in the flora of north Konkan are the same as are found in the flora of Desh side and South Gujarat. But the elements form the evergreen and semi-evergreen forests of Malabar, Karnatak and Goa are found, especially in the or Sindhudurg district. They also contain some elements from the flora of North Abyssinea, East Africa and Madagascar. A few elements are also of Malayan origin. However, the Malayan elements are only a few and are lingering, but in the evergreen forests of Mysore, North Kanara, Malabar and Nilgiris they are in greater abundance and continue further south. No plants from desert regions occur in Konkan. This and other aspects of the flora of Konkan need careful study and analysis.

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CHAPTER VIII—FLORA OF DESH

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Region to the east of Sahyadris, lying between rivers Krishna, Bhima, Sina and Godavari is recognised as Desh, comprising seven districts *viz.*, Kolhapur, Sangli, Satara, Pune, Nasik, Ahmednagar and Sholapur. Like Konkan, Desh districts are influenced by the Sahyadri. The Desh extends eastwards 563.2 Km. or more. The influence of Sahyadri on plants, animals and life of people, is evident. The rainfall in Konkan is about 2032 mm.—2540 mm. per year. On the high peaks of Sahyadri it is 3850 mm.—6350 mm., but as one goes eastwards the rainfall becomes rapidly less, and some parts are under the rain shadow. On an average it is about 608 mm.—635 mm. on Desh side, except in Ahmednagar, Sholapur and eastern parts of Pune district such as Shirur or Parner in Ahmednagar where it is less. Rain is regular and assured in Konkan, but it is erratic and not uniform on Desh. It is very uncertain in parts of Madhya Maharashtra, and has given rise to famine zone of Sholapur, eastern part of Pune district and Ahmednagar.

Climate of Konkan is humid and moderate, equable and breezy. But the climate of Desh is hot and dry, as the humidity is poor. There is about 60 per cent humidity or more for four months in a year. The ratio of humid period to dry period, 4 : 8, greatly affects the plant life and vegetation which looks dry. Plants in Konkan look always green and fresh due to high humidity 60—70 per cent throughout the year. The semi arid and dry climate of Madhya Maharashtra has given rise to dry deciduous forests all over the Desh in Maharashtra. For greater part of Desh, the trap hills look dark and barren, but in rainy season they suddenly become green due to sudden emergence of ephemeral plants sprouting all over.

Terrain of Madhya Maharashtra is terraced and uneven having variable altitude. The general slope and drainage are towards south-east. The country is crossed over by many small and large streams and rivers Krishna, Bhima and Godavari and their tributaries. They practically cut Desh into compartments by their valleys and basins.

Soils of both Desh and Konkan are derived from Deccan traps, but they are more matured and are heavy on Desh side. Konkan soils are leached every year by heavy rainfall. They are loamy and lateritic with a large proportion of iron oxides. On the Desh side they are slightly alkaline, or black cotton soils—brown or regur soils. In Konkan they are mostly gravelly or lateritic and shallow. Some look yellowish due to mixture of coastal littoral concrete. On the Desh side they are deep black or reddish. In river valleys they are alluvial.

In Kolhapur, Sangli, Satara, Pune, Nasik and western part of Ahmednagar, Sahyadri ranges run directly on their western fringe, but in other districts only their lateral extensions or spurs run, *e. g*. Balaghat, Mahadev, Garbhagiri and Satamala ranges. Parts close to direct ranges of Sahyadri are just like Konkan. They are called '*Dang*', '*Maval*' or '*Pangan*'. Their soils are lateritic or gravelly. But since the country on Desh side is terraced according to altitude, the soils are better preserved and matured and enable the people to take both *Kharif* as well as *Rabi* crops—cereals, groundnut, pulses, sugarcane, cotton, chillis etc. *Rabi* crops give better yields in river valleys. The soil elsewhere is shallow, sometimes hardly 3″, but the black cotton soils in river basins are heavy and have proved excellent for cotton, wheat, sugarcane on account of the

irrigation facilities and highly suitable seasonal climate. Given sufficient fertilizers and water, sugarcane in these districts yields higher recovery of sugar.

The average height of the Sahyadri is 1200 m. The highest peaks are in the Desh region—Kalsubai (altitude 1646 m.), Harishchandragad (1424 m), Mahabaleshwar (1438 m). The variation in local topography and soils gives rise to varied vegetation. But the overall picture of vegetation of this region is dry deciduous forest, mostly of *Tectona grandis* due to semi-arid conditions. There are no mangroves on the Desh side, nor continuous stretches of evergreen forests as in Malabar. Only some pockets of evergreen or semi-evergreen vegetation occur here in regions close to Sahyadris. When they degenerate, they produce moist deciduous forest in high rainfall regions, or change into dry deciduous forests in low rainfall areas. But when they also degenerate they form a thorn savannah or a scrub. If the soil be poor, there are only open grasslands. In many dry sandy or gravelly areas succulents and xerophytes occur. Near Daund *Acacia arabica* grows on river banks and forms a thick *Acacia* tract, which is a post-climax vegetation.

With these preliminary remarks, we shall now consider the flora and the factors affecting it in each district separately.

1. Flora of Kolhapur District

Stray references to the flora of Kolhapur are available in Literature. Prof. S. A. Parandekar had given a list of it. Diwan (1978), Mahajan and Vaidya (1969), A. R. Kulkarni and Mudgal (1971), Kulkarni and Desai (1972), Sharma and B. G. Kulkarni (1980) have worked on it. But there is no comprehensive account of the rich flora of Kolhapur. Members of the Botanical Survey such as Singh, Malhotra and Mudaliar (1972) have published account of some plants in the Flora of Kolhapur district. They enumerated 301 species inclusive of pteridophytes. Recently, however, A. R. Kulkarni and A. N. Thite (1979), have published additions to the flora of Kolhapur district (*Bom. Nat. Hist. Soc.* 74, 592—609). This is a fairly representative account of the Kolhapur district flora, and as such the plants they mentioned are given below. They have described 450 wild species, belonging to 334 genera and 114 families. It is clear that the flora of Kolhapur is pretty rich and deserves to be fully explored further.

1.1. Plants of Kolhapur District.—(Mainly Kolhapur and Panhala Area.) :

Menispermaceae :

Tinospora cordifolia (Willd) Miers.—A common climber, Kolhapur, Panhala.

Cocculus hirsutus (Linn.) Diels.—In open grasslands, Kolhapur, Panhala.

Cissampelos pareira Linn.—A climber in forests or at forest edges, Katyayani, Panhala, Gaganbavada.

Nymphaeaceae :

Nymphaea stellata Willd.—Red and white flowered forms occur. Rankala and Shiroli tank, Kolhapur.

Nelumbo nucifera Gaertn.—Laxmi Talao, Kolhapur.

Papaveraceae :

Argemone mexicana Linn.—A weed in waste land, Kolhapur, Panhala.

Brassicaceae :

Cardamine trichocarpa Hochst ex. Rich.—In moist places on walls of Panhala fort.

Cironopus didymus (Linn). Sm.—A rare garden weed.

Capparaceae :

Clemo simplicifolia Hook f. and Thoms.—Common in open grasslands, Kolhapur, Panhala.

C. viscosa Linn.—In waste lands, Kolhapur.

C. chelidonii Linn.—In puddles and along streams in mid-monsoon season, Kolhapur, Katyayani.

Cratevareligiosa Forst.—A tree near Gokhale College hostel, Kolhapur.

Cadaba indica Lam.—Along the bunds of fields, Rankala, Kolhapur.

Flacourtiaceae :

Flacourtia indica (Burm. f.) Merrill.—In open forests, Katyayani, Panhala.

Polygalaceae :

Polygala chinensis Linn.—Pasture lands, Kolhapur, Panhala. Land opposite Rankala, Kolhapur.

Portulacaceae :

Portulaca oleracea Linn.—Common along road sides, Kolhapur, Panhala.

P. grandiflora Linn.—An escape along Rankala, Kolhapur.

Elatinaceae :

Bergia ammannioides Heyne ex Roth.—Common hygrophyte near tanks at Kolhapur.

Malvaceae :

Abutilon indicum (Linn.) Sweet.—Grasslands and waste lands, Kolhapur, Panhala.

Malachra capitata Linn.—An uncommon weed.

Sida spinosa Linn.—In grasslands, Kolhapur.

Bombacaceae :

Bombax ceiba Linn.—In open forests, Panhala, Kolhapur.

Sterculiaceae :

Helicteres isora Linn.—Forest margins and clearings, Panhala, Gaganbavada.

Eriolaena quiquelocularis Wight.

Flacourtia indica (Burm.) Merrill.—In open forests, Katyayani, Panhala.

Caryophylaceae :

Saponaria vacaria Linn.—Escape from cultivation, University campus.

Polycarpon prostratum (Fork) Aschers and Schw.—Forms carpet in wet places at Katyayani and Radhanagari forests.

Tiliaceae :

Corchorus olitorius Linn.—In wàste land, Kolhapur.

Triumfetta bartramia Linn.—Forest edges and in open places, Panhala.

Malpighiaceae :

Hiptage benghalansis (Linn.) Kurz.—A woody climber with beautiful flowers at Katyayani, Panhala.

Zygophyllaceae :

Tribulus terrestris Linn.—Common in dry places, Kolhapur.

Oxaliadaceae :

Oxalis corniculata Linn.—Weed in gardens, Kolhapur, Panhala.

Biophytum sensitivum DC.—In moist places, Kolhapur.

Balsaminaceae :

Impatiens balsamina Linn.—Conspicuous in middle monsoon, Kolhapur, Katyayani, Panhala.

I. inconspicua Benth.—Common in monsoon in pastures, Radhanagari, Gaganbavada.

I. pulcherrima Dalz.—In shades plant is worthy of cultivation, Panhala, Ambaghat.

Rutaceae :

Atalantia racemosa Wight and Arn.—Panhala forests, Ambaghat.

Aegle marmelos (Linn.) Correas.—Planted in temples, Kolhapur, Katyayani.

Glycosmis pentaphylla (Retz) Correa.—Forests of Panhala, Gaganbavada, Ambaghat.

Murraya koenigii (Linn.) Spreng.—Common in forest shades,Panhala, Ambâghat.

Meliaceae :

Cipadeasa bacifera (Roth.) Mig.—Forest edges near Gaganbavada.

Heynea triguga Roxb.—Forests near Gaganbavada, Ambaghat.

Simarubiaceae :

Balanites roxburghii Planch.—Along Miraj road ; drier parts of Kolhapur district.

Opiliaceae :

Cansjera rheedii Gmel.—Open forests Katyayani, Ambaghat.

Nothopodytes foetida (Wight) Sleumer.—Common in open forests, Panhala, Ambaghat.

Sarcostigma kleinii Wight and Arn.—A climber in forests between Amba and Vishalgad.

Celastraceae :

Celastrus paniculata Willd. —A common straggler along forest margins and open areas Katyayani, Panhala.

Gymnosporia montana Benth.—Katyayani, Panhala.

Hippocrateaceae :

Pristimera grahamii (Wight) A. C. Smith.—Along fort slopes near Baji Prabhu Point, Panhala.

Rhamnaceae :

Zizyphus mauritiana Lamk.—Several trees are seen on the outskirts of Kolhapur, Katyayani and Panhala but not in actual forest areas.

Z. rugosa Lamk.—A common climber at Katyayani, Panhala, Gaganbavada and Amabghat.

Z. oenoplia Mull.—In grasslands of Kolhapur.

Vitaceae :

Cayratia elongata (Roxb.) Suesseng.—Very common climber Panhala and Gaganbavada.

Cissus pallida Planch.—Rocky areas at the base of Panhala fort.

Leea macrophylda Roxb. ex Horneum.—Quite common in cleared forests, Katyayani.
L. indica (Burm). Merrill.—Very common shrub in forest margins, Panhala Gaganbavada, Radhanagari, Ambaghat.

Sapindaceae :
Allophyllus serratus (Roxb) Radlk.—Scandent shrub in forest shade, Panhala, Gaganbavada.
Cardiospermum helicacabum Linn.—In grassland, Kolhapur, Katyayani, Panhala.
Schleichera oleosa (Laur.) Oken.—Forests at Katyayani ; not common.
Sapindus laurifolius Vahl..—Near human dwellings.

Anacardiaceae :
Mangifera indica Linn.—Abundant in Panhala and Amba.
Lannea coromandelica (Houtt.) Merrill.—A small tree, Katyayani, Panhala fort.
Semecarpus anacardium Linn.—A few trees near Katyayani temple.
Holigarna grahami (Wight) Hook. f.—In Ambaghat forests.
Nothopegia colebrookiana Blume.—Forests of Ambaghat and Radhanagari.

Fabaceae :
Coniogyna hirta (Willd.) Ali.—Very common in Pasture lands.
Crotalaria filipes Benth. var. *trichocarpa* Benth (Ex Baker) Cooke Pasture lands, Kolhapur, Panhala.
C. juncea Linn.—A escape at Kolhapur.
C. lutescens Dalz.—In grasslands, Kolhapur, Panhala.
C. orixensis Willd.—University campus, Kolhapur.
C. prostrata Roxb.—Amongst grasses, Panhala.
C. spectabilis Roth.—Grasslands, Katyayani.
C. vestita Baker.—Along forest margins and grasslands, Panhala.
Indigoferia cordifolia Heyne ex Roth.—In grasslands.
I. dalzellii Cooke.—In moist rocky places, Panhala.
I. linnaei Ali.—In grasslands, Kolhapur.
I. hendecaphylla Linn.—Moist open places and grasslands at Rankala, Panhala.
I. linifolia Retz.—Pasture lands, Kolhapur.
I. pulchella Roxb.—A shrub in grasslands, Panhala.
I. tinctoria Linn.—In waste lands, Kolhapur, Panhala.
I. trita Linn.—Kolhapur, Katyayani, Panhala.
I. taphrosia coccinea Wall.—A shrub in open land, Radhanagari.
I. pumila Pers.—Grasslands of Kolhapur (rare).
I. purpurea Pers.—A shrub of grasslands, Kolhapur, Panhala.
I. strigosa (Dalz). Santapau.—In grassland, Kolhapur.
Geissaspis cristata Wight and Arn.—Grasslands, Panhala.
Zornia diphylla Pers.—Common in grasslands.
Smithia bigemina Dalz.—Very common, attractive in grasses in monsoon, Ambaghat, Panhala.
S. blanda var. *racemosa* Baker.—Kolhapur, Panhala.
S. conferta Sm.—University campus, Kolhapur, Panhala.
S. setulosa Dalz.—Grassy places, Kolhapur.
Aeschynomene indica Linn.—Common monsoon herb in moist places, Kolhapur.
A. aspera Linn.—Vadanige lake near Kolhapur.
All species of *Alysicarpus* noted below are found in grasslands.
Alysicarpus belgaumensis Wight.—Radhanagari.
A. bupleurifolius DC.—Kolhapur.

A. pubescens Law.—Kolhapur.
A. rugosus DC.—Kolhapur.
A. rugosus var. *heyneanus* Baker.—Kolhapur.
A. tetragonolobus Edgew.—Kolhapur, Panhala.
A. vaginalis DC.—Kolhapur, Panhala.
Desmodium diffusum DC.—Amongst grass, Kolhapur.
D. gangeticum (Linn.) DC.—A shrub in open places and forest clearings, Panhala, Gaganbavada, Radhanagari.
D. latifolium DC.—An undershrub with spreading branches, Panhala.
D. laxiflorum DC.—Undershrub, Kolhapur, Panhala.
D. polycarpum DC.—Often in shades of forest trees, Gaganbavada, Radhanagari.
D. rotundifolium Baker.—Spreading herb in grasses Katyayani, Panhala.
D. triflorum (Linn.) DC.—Very common in rocky areas, Panhala, Radhanagari.
D. triquetrum DC.—Panhala.
Abrus precatorius Linn.—A climber in forests or along forest margins, Gaganbavada, Radhanagari.
Teramnus labialis Spreng.—A twiner along forest edges.
Mucuna prurita Hook.—Forest edges, Gaganbavada.
Erythina variegata Linn. var *orientalis* (Linn.) Merr.—Some trees here and there.
Butea monosperma (Lamb.) Taub.—Dry areas around Kolhapur, Katyayani.
Pueraria lobata (Willd.) Ohwi.—Amongst grasses Kolhapur.
Clitoria ternatea Linn.—In hedges or often cultivated.
Atylosia scarabaeoides Benth.—Forests of Radhanagari.
Moghnnia strobilifera (Linn.) St. Hil ex Jacks.—At the edges of forests, Radhanagari, Panhala.
Dalbergia latifolia Roxb.—A few trees at the base of Panhala fort infected with *Viscum angulatum.*
D. sympathetica Nimmo ex Grah.—A hooked climber, common in forests of Panhala, Radhanagari and Ambaghat.
Derris indica Lamk. Bennet (*Pongamia pinnata* (Linn.). Pieerre).—Common around Kolhapur, Panhala.

Caesalpinaceae :

Caesalpinia sepiaria Roxb.—Along bunds of sugarcane fields. Panhala fort near Jebak bag.
Wagatea spicata Dalz.—In forests of Panhala, Ambaghat.
Cassia fistula Linn.—Panhala, Radhanagari.
C. sophora Linn.—Katyayani, near Phule Wadi, Kolhapur.
C. tora Linn.—In waste lands, Kolhapur.
C. absus Linn.—Among grass, Katyayani, Kolhapur.
C. pumila Lamk.—In pasture lands, Kolhapur.

Mimosaceae :

Entada scandens Benth. (=*E. pursaetha*).—In dense forests of Radhanagari and Ambaghat.
Dichrostachys cinea Wight and Arn.—In rocky open areas, Kolhapur.
Mimosa pudica Linn.—A weed.
M. hamata Willd.—Rocky open areas of University Campus, Kolhapur.
Acacia concinna DC.—Common at Panhala.

Crassulaceae :

Bryophyllum pinnatum (Lam) Oken.—In moist places, Panhala, Ambaghat.

Droseraceae :

Drosera burmanni Vahl.—Along margins of temporary ponds near Amba village.

D. indica Linn.—In most places among grasses near Panhala, Kolhapur.

Rhizophoraceae :

Carallia brachiata (Laur.). Merril.—In dense forests of Radhanagari and Ambaghat.

Combretaceae :

Terminalia chebula Retz.—Very common in Ambaghat, Panhala, Gaganbavada forests.

Terminalia bellerica (Gaertn.) Roxb.—Panhala.

T. crenulata Roth.—Panhala and Radhanagari.

Myrtaceae :

Syzygium cumini (Linn.) Skeels.—Abundant in Panhala.

Loecythidaceae :

Careya arborea Roxb.—Common in Panhala, Radhanagari and Gaganbavada forests.

Melastomaceae :

Osbeckia truncata D. Don ex W. and A.—In grasslands and moist rice fields, Gaganbavada.

Lythraceae :

Rotala densifolora (Roth.) Koehnne.—In moist places along margins of ponds and puddles, Panhala.

Ammannia baccifera Linn.—In marshes, Kolhapur.

Woodfordia fruticosa (Linn.) Kurz.—In forest clearings near Radhanagari, Gaganbavada : Sometimes on old fort walls, Panhala.

Onagraceae :

Ludwigia perennis Linn.—In marshy places, Kolhapur.

Cucurbitaceae :

Trichosanthes bracteata (Lamk.) Voight.—A common climber at Panhala and Gaganbavada.

T. cucumerina Linn.—Rare twiner, Panhala.

Bryonopsis laciniosa Naud.—Often on hedges, Katyayani.

Melothria maderaspatna Cogniaux.—Very common in Kolhapur.

Begoniaceae :

Begonia crenata Dryand.—Pretty common in moist places at Panhala, Gaganbavada, Ambaghat, Radhanagari.

B. trichocarpa Dalz.—On forest trees at Gaganbavada.

Cactaceae :

Opuntia dillenii Haw.—A weed of dry localities.

Molluginaceae :

Glinus lotoides O. Kunze.—Growing on moist clayey soils.

Mollugo pentaphylla Linn.—Common in moist places of Kolhapur, Panhala.

M. pentaphylla var *rupestris* Cooke.—In moist rocky places around Panhala.

Aizoaceae :

Trianthema portulacastrum Linn.—Along road sides.

Apiaceae :

Contella asiatica (Linn.).—N. A.
Pimpinella adscendens Dalz.—In grasslands.
P. lateriflora Dalz and Gibs.—In forest clearings on way to Gaganbavada.
Peucedanum dhana Ham. In grasslands of Kolhapur.

Rubiaceae :

Anotis foetida (Dalz.) Benth and Hook.—Herb in rocky moist areas.
A. lancifolia (Dalz) Hook f.—Abundant and conspicuos monsoon herb in grasses, Jyotiba, Panhala.
A. montholoni Hook f.—In grasses, University campus, Kolhapur.
A. rheedei Benth and Hook f.—Jyotiba, Panhala.
Borreria hispida (Linn.) Schum.—Rocky places, University campus, Kolhapur.
Canthium parviflorum Lamk.—Not common, near Rankala.
C. dicoccum (Gaertn.) Merrill.—Forest of Ambaghat.
Dentella repens (Linn.) Forsk.—Mat-forming hygrophyte. Kaga Lake, Rajaram tank, Kolhapur.
Hamiltonia suaveolens Roxb.—Amongst stone crevices of Sadoba tank, Panhala.
Hymenodictyon obovatum Wall.—Along slopes towards fort, Gaganbavada along Rajdindi road, Panhala, Vishalgad, Ambaghat.
Ixora arborea Roxb. ex. Sm.—Common small tree in forest, Panhala.
I. elongata Heyne.—Behind Katyayani temple, Katyayani.
Meyna laxiflora Robyns.—Rocky grasslands, Kolhapur.
Oldenlandia crystallina Roxb.—In moist rocky places, Panhala.
O. corymbosa Linn.—Pasture lands, Panhala.
O. herbacea (Linn.) Roxb. Panhala.
Pavetta indica Linn.—At edges of forests and along cleared areas, Panhala, Gaganbavada, Radhanagari.
Randia uliginosa DC.—Behind Katyayani temple. A few trees.
Rubia manjith Roxb. en Flem.—Panhala.
Wendlandia thyrosoidea Steud.—Along forest edges, Panhala.
Xeromphis spinosa (Thunb.) Keay.—Very common on Panhala fort plateau.

Asteraceae :

Acanthospermum hispidum DC.—A weed.
Artemisia vulgaris Linn.—Along edges of Jabak Udyan, Panhala.
Bidens biternata (Lour.) Merr and Sheff.—A weed at Gopaltirth, Panhala, Kolhapur.
Blumea malcolmii Hook. f.—Densely hairy herb in open areas ; post harvest weed in rice fields.
B. membrenacea DC.—In dry areas.
Caesulia axillaris Roxb.—Common in marshy places, Kolhapur.
Cyathocline purpurea (D. Don) O. Ktze.—Weed in rice fields.
Elephantopus scaber Linn.—Shady forest clearings Panhala, Ambaghat.
Eclipta prostrata Linn.—Common in grasses along road sides, Kolhapur.
Echinops echinatus Roxb.—Dry rocky places, Kagal.
Flaveria contrayerba Pers.—Weed in waste places.
Gynura angulosa DC.—Edges and slopes of Ambaghat.
Gnaphallum indicum Linn—Moist and marshy places, Rajaram tank Kolhapur.
Lactuca juncinata DC.—A weed in cultivated fields.
Lagascea mollis Cav.—Quite common and gregarious in waste places, Kolhapur.

Parthenium hysterophorus Linn—A rapidly spreading dangerous weed, Kolhapur.
Pulicaria wightiana C. B. Clarke.—Amongst grasses, Kolhapur.
Senecio grahami Hook. f.—Often on old walls, Panhala.
Sphaeranthus africanus Linn.—Forest edges, Panhala.
Tridar procumbens Linn.—In rocky dry places along road sides, Kolhapur, Panhala.

obeliaceae :
Lobelia alsinoides Lamk.—In pasture lands, Panhala, Gaganbavada.
L. heyneana Roem. and Sch. —Pasture lands, Amba village.
L. nicotianaefolia Heyne.—In dense forests and forest edges, Panhala, Ambaghat.

Plumbaginaceae :
Plumbago zeylanica Linn.—In dry open areas, Kolhapur.

Primulaceae :
Anagallis arvensis Linn.—Along road side, Kolhapur.
A. pumila Swart.—Monsoon herb in pasture lands at the Panhala fort.

Myrsinaceae :
Maesa indica Wall.—Along forest edges, Panhala (Rare), common at Radhanagari.
Embellia tjariam (E. ribes) Cottom A. DC.—Katyayani (Rare).

Sapotaceae :
Xantolis tomentosa (Roxb.) Raf.—Common in Panhala on way to Tin Darwaja from Sadoba darga.
Mimusops elengi Linn.—Very common on Panhala plateau.

Ebenaceae :
Diospyros montana Roxb.—Generally in association with *Xantolis tomentosa*, Panhala.

Oleaceae :
Jasminum malabaricum Wight.—Katyayani, Panhala, Gaganbavada, Ambaghat. Very common in all places.
Schrebera swietaeoides Roxb.—Noticeable near Gaganbavada village on way to fort.

Apocynaceae :
Carissa congesta Wight.—Gregariously growing at Panhala, Katyayani.
Rauvolifia conescens Linn.—A rare weed at Kolhapur.
Catharanthus pusillus (Murr.) G. Don.—A weed in gardens, Kolhapur.
Alstonia scholaris (Linn.) R. Br.—Near Amba village.
Holarrhena antidysenterica Wall.—Common at Katyayani, Panhala and Gaganbavada.
Tabernaementana heyneana Wall.—Along road sides between Amba village and rest house.
Vallaris solanecea (Roth.) Kuntze.—Pusati point along fort wall, Panhala.

Periplecaceae :
Hemidesmus indicus R. Br.—Common in forest clearings, Panhala, Gaganbavada.
Crypotolepis buchanani Roem and Schult.—Common Kolhapur, Katyayani, Panhala.

Asclepiadaceae :

Asclepias curssavica Linn.—Kolhapur.

Calotropis gigantea R. Br.—In waste lands, Kolhapur, Panhala.

Ceropegia attenuta Hook.—In grasslands, Katyayani.

C. tuberosa Roxb.—In forests at Panhala.

C. huberi Ansari.—Along forest slopes of Ambaghat.

Dregea volubilis Benth ex. Hook.—Near Rajaram tank, Kolhapur, Ambarkhana border, Panhala.

Gymnema sylvestrais (Ret.) R. Br.—Panhala.

Hoya pendula Wight and Arn.—In forests of Ambaghat.

Leptadenia reticulata Wight and Arn.—Forest edges, Gaganbavada, Panhala.

Pergularia daemia (Forsk.) Blatt and Mcc.—In hedges Kolhapur, Gaganbavada.

Tylophora dalzellii Hook f.—Common at Panhala.

Loganiaceae :

Strychnos colubriana Linn.—Forests near Gaganbavada.

Menyanthaceae :

Nymphoides indicum (Linn.) O. Kuntze.—Rankala tank, Kolhapur, Kagal lake.

N. cristatum (Roxb.) O. Kuntze.—Panhala, Kolhapur, lake at Kagal.

Gentianaceae :

Canscora diffusa R. Br.—In moist places along slopes. Katyayani, Gaganbavada, Ambaghat.

Centaurium roxburghii (G. Don) Druce.—In moist places on University campus, Kolhapur.

Exacum bicolor Roxb.—On way to Katyayani; along pasture lands, Panhala.

E. lawii Clarke.—In pasture lands, Kolhapur, Panhala, Gaganbavada.

E. petiolare Griseb.—In pasture lands, Kolhapur.

Ehretiaceae :

Cordia dichotoma Forsk. f.—Common at Panhala, Katyayani.

Boraginaceae :

Adelocaryum coelestinum (Lindl.) Branch.—Along slopes of Ambaghat.

Coldenia procumbens Linn.—Rajaram tank, Kolhapur.

Cynoglossum meeboldii Branch.—Forest edges, Panhala, Radhanagari.

Heliotropium ovalifolium Forsk.—In grassy places, Kolhapur.

Trichodesma amplexicaule Roth.—A weed in fields and waste lands, Kolhapur.

Cuscutaceae :

Cuscuta reflexa Roxb.—Common, specially on hedges on *Clerodendon, Duranta, Vitex.*

Convolvulaceae :

Argyreia hookeri Clarke.—Common at Panhala, Ambaghat.

A. elliptica Choisy, Panhala.

Convolvulus arvensis Linn.—A weed.

Erycibe wightiana Graham.

Evolvulus alsinoides Linn.—In grasslands.

Ipomoea aquatica Forsk.—Common in all tanks at Kolhapur, Vadanage, Kagal.

I. cairica (Linn.) Sweet.—Extensively cultivated and run wild.

I. longiflora R. Br.—Along hedges with prominent subspinous tubercles; near Rankala, Kolhapur.
I. obscura Ker.—Gavad, Ambaghat.
Merremia hastata Hallier.—In dry rocky areas of Kolhapur.

Solanaceae :
Datura matel Linn.—Common weed.
Nicandra physaloides (Linn.) Gaertn.—Weed.
Physalis minima Linn.—Weed.
Solanum nigrum Linn.—Weed.
S. surattense Burm. f.—In dry rocky areas along road sides.
S. indicum Linn.—Very common throughout Panhala, Katyayani.
S. tortum.—Along bunds of sugarcane fields.
S. seaforthianum Andr.—Escape from cultivation, Rankala, Kolhapur, Panhala.
Withania somniferum Linn.—Weed in waste places, Kolhapur.

Scrophulariaceae :
Artanema longifolia (Linn.) Merrill.—In grasslands of Gaganbavada, Radhanagari and Amba.
Bacopa monnieri (Linn.) Pennell.—Common in ditches, Kolhapur, Radhanagari.
Dopatorium junceum (Roxb.) Buch. Ham.—Marshy places, Kolhapur, Katyayani.
Kickxia ramosissima (Wall.) Janchen.—On fort walls and old buildings, Kolhapur, Panhala, Gaganbavada.
Limnophila sessiliflora Blume.—Common in many tanks around Kolhapur.
Lindernia anagallis (Burm.) Pennell.—A weed in rice fields, and marshy places.
L. ciliata (Colms.) Pennell.—A monsoon herb in moist places.
L. crustaceae (Linn.) J. Mueller.—Moist places, Panhala, Malkapur.
L. parviflora (Roxb.) Haines.—Herb in marshes, Kolhapur, Katyayani, Kadamwadi, Gaganbavada.
Mimulus strictus Benth.—Kolhapur, Katyayani, Gaganbavada.
Peplidium meritimum (Linn.) Wettst.—Marshes of Vadanage lake near Kolhapur.
Rhamphicarpa longiflora (Arn.) Benth.—Moist places pasture lands.
Sopubia delphinifolia (Roxb.) G. Don.—Grasslands, Panhala.
Stemodia viocssa Roxb.—A hygrophyte, Kolhapur, Radhanagari.
Striga densiflora Benth.—Weed in jowar and sugarcane fields, Kolhapur Tandulwadi, Gaganbavada.
S. euphrasicides (Vahl) Benth.—Grasslands, Kolhapur.
S. gesneroides (Willd.) Vatke.—Panhala, Ambaghat.
S. sulphurea Dalz and Gibs.—Amongst grasses, Kolhapur, Gaganbavada.
Verbascum chinense Santapau.—Along road side Malkapur, Radhanagari, Kolhapur.

Orobanchaceae :
Aeginetia indica Linn.—A root parasite in dense forests, Gaganbavada, Ambaghat.
Christisonia calcarata Wight.—Parasite on roots of *Carvia callosa* on way to fort top, Gaganbavada.

Gesneriaceae :
Klugia notoniana (Wall.) A. DC.—Moist wall crevices, Panhala, Gaganbavada.
Rhynchoglossum obliquum Blume var. *parviflora* Clarke.—On forest slopes areas, Gaganbavada.

Bignoniaceae :

Heterophragma quadriloculare (Roxb.) K. Schum.—Common at Panhala and Katyayani.

Tecoma stans (Linn.) H. B. and K.—In dry places around Kolhapur, base of Panhala fort.

Pedaliaceae :

Sesamum laciniatum Klein ex Willd.—Common around Kolhapur and near Kagal in dry rocky soils in grasses.

Martyniaceae :

Martynia annua Linn.—In waste places.

Acanthaceae :

Adhatoda vasica Nees.—Panhala, Gaganbavada.

Andrographis paniculata (Burn f.) Wall ex. Nees.—Along forest edges Jyotiba, Panhala.

Asteracantha longifolia (Linn.) Nees.—Along sewage canals, Kolhapur.

Asystasia dalzellina Santapau.—Near Tin Darwaja and Tabak Udyan, Panhala.

A. lawiana Dalz.—Behind Katyayani temple.

Barleria cristata Linn.—In hedges (cultivated).

B. gibsoni Dalz.—Grasslands, Katyayani.

B. prionitis Linn.—Common in hedges.

Blepharis asperrima Nees.—Under the shade of forest trees, Panhala, Ambaghat.

Carvia callosa (Wall.) Brem.—Thickets along slopes to Gaganbavada.

Eranthemum roseum R. Br.—In shade, Panhala, Gaganbavada.

Haplanthus verticillatus (Roxb.) Needs.—Along forest edges in shade, Panhala.

Lepidagathis cristata Willd.—Amongst grasses, Kolhapur, Kagal, Panhala.

Justicia betonica Linn.—Panhala.

Peristrophe bicalyculala (Retz.) Nees.—Panhala, Jyotiba.

Rostellularia crinita Nees.—Road sides, Kolhapur.

Rungia elegans Dalz. and Gibs.—Along road sides, Kolhapur.

R. pectinata (Linn.) Nees.—Amongst grasses, Panhala.

Verbenaceae :

Calicarpa tomentosum (Linn.) Murray.—Forest, Panhala, Ambaghat.

Clerodendrum fragrans (Vent.) R. Br.—Mostly cultivated but grows as an escape in Panhala.

C. viscosum Vent.—Very common in forest clearings, Katyayani, Panhala, Radhanagari, Gaganbavada.

C. serratum (Linn.) Moon.—In grasslands, specially in forest clearings. Katyayani, Panhala, Radhanagari, Gaganbavada.

Duranta repens Linn.—A hedge plant.

Lantana camara Linn. var. *aculeata* (Linn.) Moldenke.—Common in Panhala.

Phyla nodiflora (Linn.) Green.—Common in moist places.

Stachytarpheta jamaicensis (Linn.) Vahl.—Rare. Near Tabak Udyan and Tin Darwaja, Panhala.

Vitex negundo Linn.—Very common around dwellings.

Lamiaceae :

Anisochilus carnosus Wall.—Very common in rainy season on tiled roofs.

Colebrookia oppositifolia Sm.—In forest clearings at Jyotiba

Dysophylla stellata Benth.—In puddles and marshes, Kolhapur, Panhala, Gaganbavada.
Hyptis suaveolons (Linn.) Point.—Gregarious in waste places, Kolhapur.
Lavandula burmanni Benth.—Amongst grasses, Kolhapur, Panhala.
Leonurus sibirius Linn.—Behind Jyotiba temple in waste places, Jyotiba.
Leucas aspera Spreng.—Amongst grass at Kolhapur.
L. biflora R. Br.—Amongst grass at Kolhapur.
L. ciliata Benth.—In grasslands and forest clearings, Panhala, Gaganbavada.
L. stelligera Wall. ex Benth.—In grasslands, Panhala, Gaganbavada.
L. urticifolia R. Br.—Kadamwadi near Kolhapur.
Plectranthus incanus Link.—Katyayani, Panhala fort (Rare).
Pogostemon plectranthoides Desf.—Gregarious in Panhala, Radhanagari.

Plantaginaceae :
Plantago major Linn.—Along Panchaganga river, Kolhapur.

Nyctaginaceae :
Boerhaavia diffusa Linn.—Pretty common in Kolhapur.

Amaranthaceae :
Achyranthes aspera Linn.—Amongst grasses.
Aerva sanguinolenta (Linn.) Blume.—Forest edges, Panhala.
Alternanthera pungens H. B. S. K.—In dry rocky places, Kolhapur, Panhala.
A. sessilis (Linn.) DC.—A weed in damp and waste land.
Amaranthus spinosus Linn.—In waste lands, Kolhapur, Panhala.
Celosia argentea Linn.—Weed in fields.
Digera alternifolia (Linn.) Aschers.—In grasses and along road sides.
Gompherena celosioides Mart.—In waste lands, Kolhapur, Panhala.
G. globosa Linn.—Often found as an escape, University campus, Kolhapur.

Chenopodiaceae :
Chenopodium ambrosioides Linn.—Weed in gardens, Kolhapur.

Polygonaceae :
Antigonum leptopus Hook. and Arn.—Cultivated but has run wild at Panhala.
Polygonum chinense Linn.—Very common in Panhala, Gaganbavada.
P. glabrum Willd. —Marshes of Kolhapur, Shiroli Talao, Vadanage talao near Kolhapur.
P. plebejum R. Br.—Very common in all marshes and damp localities.

Podostemaceae :
Terniola zeylanica (Gardn.) Tul.—In streams of Ambaghat and Radhanagari.
Griffithella hookeriana (Tul.) Warming.—Near Gaganbavada in streams.

Piperaceae :
Piper hookeri Mug.—In forests of Ambaghat.
P. longum Linn.—In shady places along the bunds of sugarcane fields near Rankala.

Lauraceae :
Cinnamomum zeylanicum Blume area of Radhanagari forest.
Alseodaphne semicarpifolia Nees.—Ambaghat.

Thymelaeaceae :

Lasiosiphon eriocephalus Decne.—Very common along forest clearings, Panhala, Radhanagari, Gaganbavada, Katyayani and Ambaghat.

Elacagnaceae :

Elaeagnus conferta Roxb.—Ambaghat on way to Pratapnagar.

Dendrophthoe falcata (Linn. f.) Etting.—Common on *mangifera indica, Melilotus philippiensis* at Panhala.

Viseaceae :

Viscum angulatum Heyne ex. DC.—On *Dalvergia latifolia* at Panhala, on *Terminalia chebula* at Radhanagari.

Santalaceae :

Oxyris wightiana Wall ex Wight.—In forest at Katyayani, Panhala.

Santalum album Linn.—Panhala, Kolhapur (cultivated).

Euphorbiaceae :

Acalypha ciliata Forsk.—Grows in crevices of walls.

Bridelia samosa (Lamk.) Gehrm.—Common at Panhala.

Chrozophora rottleri (Geis.) Juss ex. Spr.—Weed in cultivated fields and puddles, Kolhapur.

Croton bonplandianum Baill.—A weed of waste land.

Emblica officinalis Gaertn.—Radhanagari forests.

Euphorbia geniculata Orteg.—In waste lands, Panhala.

E. hirta Linn.—Throughout on plains of Kolhapur.

E. neriifolia Linn.—On rocky slopes Ambaghat, Gaganbavada.

E. rothiana Spreng.—Amongst grasses in forest clearings, Gaganbavada.

E. thymifolia Linn.—Very common everywhere.

Glochidion hohenackeri Bedd.—Panhala, Radhanagari.

G. malabaricum Bedd.—Katyayani, Panhala.

Jatropha cureas Linn.—Near human habitation, Kolhapur, Panhala.

J. gossypifolia Linn.—In waste land in Rajarampuri.

Kirganelia reticulata (Poin) Baill.—In open places, Panhala.

Macaranga peltata (Roxb.) Muell.-Arg.—Radhanagari; Ambaghat.

Melanthesa turbinata (Roen. ex Roxb.) Wight.—Along forest edges, Panhala, Gaganbavada.

Mallotus philippiensis (Lamk.) Muell. Arg.—Very common Panhala, Katyayani, Gaganbavada, Ambaghat.

Phyllanthus asperulatus Hutch.—In grasslands.

P. urinaria Linn.—Grassland, Kolhapur.

Sapium insigne Trimen.—Forest margins and clearings, Rajdindi road, Panhala, Gaganbavada; along streams near Amba Tanin Factory, Amba.

Securinega leucophyrus (Willd.) Muell. Arg.—Common in open areas.

Tragia muelleriana var. *unicolor* (Muell. Arg.) Pax and Hoffm. Under shades of forest trees.

Ulmaceae :

Celtis cinnamomea Lindl.—Very common in Panhala but not in other areas of Kolnapur district.

Trema orientalis (Linn.) Blume.—Common, Panhala, Kolhapur.

Moraceae :

Ficus asperrima Roxb.—A common shrub at Panhala.

F. glomerata Roxb.—Cultivated.

F. rumphii Blume.—Common along fort walls, Panhala

F. tsiela Roxb.—Cultivated at Panhala.

Urticaceae :

Boehmeria scabrella (Roxb). Gaud.—Stinging herb in shades.

Fleurya interrputa (Linn.) Gaud.—Common on old walls.

Girardinia zeylanica Decasne.—In waste land during rains.

Lecanthus peduncularis (Wall.) Bedd.—Succulent herb in walls and moist localities.

Pilea microphylla (Linn.) Liebm.—Naturalized in damp places, Kolhapur, Panhala.

Pouzolzia zeylanica (Linn.) Benn.—In rocky moist areas of Gaganbavada.

P. pentandra Benth.—Along streams.

Salicaceae :

Saliz tetrasperma Roxb.—Along river beds and streams, Kolhapur, Malkapur.:

Ceratophyllaceae :

Ceratophyllum demersum Linn.—Common in all lakes.

Hydrocharitaceae :

Blyxa octandra (Roxb.) Planch. ex. Thw.—Submerged herbs with purplish tufted leaves, in Kagal lake.

Hydrilla verticillate (Linn. f.) Royle.—All lakes, ponds and puddles of Kolhapur.:

Vallisneria spiralis Linn.—Common in water streams.

Burmanniaceae :

Burmannia pusilla (Wall. ex Miers.) Thw.—In pastures during September-October, Gaganbavada.

Orchidaceae :

Dendrobium barbatulum Lindl.—Common in forests of Panhala, Radhanagari and Ambaghat.

D. microbulbon A. Rich.—Near Gohlana, Radhanagari.

Eria dalzellii Lindl.—Radhanagari, Ambaghat.

Eulophia pratensis Lindl.—Marshes of Kagal lake.

E. nuda Lindl.—In shades of forest trees, Ambaghat.

Habenaria commelinifolia Wall. ex. Lindl.—Grasslands,.

H. grandiflora Lindl.—In grasslands, very common.

H. longicalcarata A.—Dense grasslands, Kolhapur.

H. marginata Coleb.—In rice fields, Kolhapur, Panhala.

Oberonia recurva Lindl.—On trees at Panhala, Gaganbavada, Radha nagari and Ambaghat.

Vanda parviflora Lindl.—Panhala, Radhanagari.

Zingiberaceae :

Curcuma inodora Grah.—Very common along forest edges, Panhala, Gaganbavada, Radhanagari.

Curcuma sp. Undergrowth in dense forests, Panhala, Radhanagari.

Hedychium coronarium Koen.—Kolhapur.

Zingiber cernuum Dalz.—Undergrowth in dense forests, near Gaganbavada.

Costaceae :

Costus speciosus ((Koenig) Smith.—Common along forest edges, Panhala, Gaganbavada, Radhanagari, Ambaghat.

Cannaceae :

Canna indica Linn.—An escape.

Musaceae :

Ensete superbum (Roxb.) Cheesman.—Along ghat slopes.

Hypoxydaceae :

Curculigo orchioides Gaertn.—In open grasslands and forest clearings.
Hypoxis aurea Lour.—Common in pastures.

Amaryllidaceae :

Crinum latifolium Linn.—Along streams, Kolhapur, Katyayani.

Agavaceae :

Agave vera-cruz Mull.—Escape, Panhala.

Dioscoriaceae :

Dioscoria bulbifera Linn.—Common at Katyayani, Panhala, Gaganbavada, Radhanagari.
D. pentaphylla Linn.—In all forests.
Asparagus racemosus Willd. var. *javenica* Baker.—Katyayani, Panhala, Gaganbavada, Ambaghat forest margins and clearings.
Asphodelus tenuifolius Car.—Weed in cultivated fields.
Chlorophytum glaucum Dalz.—Gaganbavada, Radhanagari (Rare).
C. laxum R. Br. Pasture lands of Kolhapur, Panhala.
Gloriosa superba Linn.—In forest clearings, Katyayani, Panhala, Ambaghat.
Iphigenia indica (Linn.) A Gray.—In grasslands, Panhala, Radhanagari.
I. pallida Baker.—Common in pasture lands.
Ledebouria hyacinthiana Roth.—In pasture lands, Kolhapur, Radhanagari.
Smilax zeylanica Linn.—Common.
Urginea indica (Roxb.) Kunth.—Common in pasture lands of Kolhapur, Kagal.

Pontederiaceae :

Monochoria vaginalis (Burm. f.) Presl. ex Kunth.—Along marshes of Vadanage lake near Kolhapur ; rare.
Eichhornia crassipies (Mart.) Solms.—Common along Panchaganga river, Rankala tank, puddles at Kolhapur.

Arecaceae :

Phoenix sylvestris Roxb.—Along nalas at Kolhapur.
Caryota urens Linn.—In forests of Panhala, Gaganbavada and Ambaghat.

Pandanaceae :

Pandanus odoratissimum Linn. f.—Kagal stream near Kolhapur, Katyayani, Radhanagari along streams.

Typhaceae :

Typha augustata Bory and Chaub.—Common in marshes, Kolhapur, Kagal, Shiroli.

Araceae :

Ariopsis peltata Nimmo.—Generally epiphytic, sometimes in rock crevices, abundant at Panhala and Radhanagari.
Arisaema murrayi Hook.—Katyayani, Panhala, Gaganbavada.
Colocasia esculenta (Linn.) Schott.—An escape.
Pothos scandens Linn.—Forests of Radhanagari.

Lemnaceae :

Lemna paucicostata Hegalmaier.—In stagnant ponds at Kolhapur.
Spirodella polyrrhiza (Linn.) Schleid.—Kolhapur.

Potamogetonaceae :

Potamogeton nodosus Poir.—In all tanks around Kolhapur, Shirali, Vadanage and Kagal.
P. pectinatus Linn.—Kagal Lake.

Najadaeceae :

Najas gramines Del.—Common in ponds.

Besides these wild plants, some other useful plants were introduced in Tabak baug at Panhala at the suggestion of Chhatrapati Shahu Maharaj of Kolhapur such as tea, coffee, ornamental gymnosperms like species of *Cupressus torulosa* etc. He also introduced some new plants at Dajipur and Radhanagari forests.

1·2. Grasslands of Kolhapur :

Kolhapur stands at an altitude of more than 2000 . The winds in the end part of summer are quite heavy. Due to this soil layers on the top of trap rocks get eroded. The rocks contain small pebbles and poor unfertile sand and gravel. In monsoon a number of these areas allow grass to grow and form temporary grasslands in open areas and on waste lands. Grass also grows in denuded areas of forest, and on areas made barren by human interference. Prof. S. D. Mahajan has collected the grasses around Kolhapur and they are enlisted here. They contain fodder grasses, thatch grasses and some weeds. Some grasses such as *Ischemum* would be a good source of material for paper pulp. As indicated by Puri and Mahajan (1968) Radhanagari forest, particularly, would be a good source of species for several economic and medicinal purposes.

These grasslands around Kolhapur contain many other plants also as given below :—

Orchidaceae	Flowering Season
Eulophia pratensis Lindl.	Nov.—Feb.
Zeuxine sulcata Lindl.	Dec.-Jan.
Habenaria digitata Lindl.	July
Habenaria marginata Coleb.	Aug.
Habenaria rariflora A. Rich.	July-Aug.
Habenaria grandiflora Lindl.	July
Amaryllidaceae :	
Hypoxis aurea Lour.	July
Liliaceae :	
Asparagus racemosus Willd. var. *Javanica* Baker	
Iphigenia indica A. Gray	June-July
Scilla indica Baker	May—July
Commelinaceae :	
Commelina nudiflora Linn.	Dec.
Commelina bengalensis Linn.	Aug.—Dec.
Commelina forskalaei Vahl.	Nov.

Orchidaceae	Flowering Season
Aneilema nudiflora R. Br.	Sept.
Cynotis tuberosa Schultes	Aug.
Cynotis fasciculata Schultes	Sept.-Oct.
Cynotis cristata Schultes	Aug.—Oct.
Cynotis axillaris Schultes	Aug.-Sept.

Eriocaulaccae :

Eriocaulon minutum Hook.	Aug.-Sept.
Eriocaulon luzulaefolium Mart.	Sept.—Nov.

Cyperaceae:

Cyperus pumilus Linn.	Sept.
Cyperus globosus All.	
Cyperus pygmaeus Rottb.	Nov.
Cyperus diformis Linn.	Oct.—Jan.
Cyperus arenarias Retz.	Sept.—Nov.
Cyperus haspan Linn.	Oct.—Dec.
Cyperus compressus Linn.	Sept.—Nov.
Cyperus aristatus Rottb.	Sept.
Cyperus iria Linn.	Dec.
Cyperus nutans Vahl.	Sept.
Cyperus eleusinoides Kunth	Sept.
Cyperus rotundus Linn.	Sept.—Nov.
Cyperus exaltatus Retz.	Sept.
Maniscus panicaus Retz.	Sept-Oct.
Kyllinga triceps Rottb.	Sept.
Fimbristylis dichotoma Vahl.	Oct.—Apri.
Fibristylis aestivalis Vahl.	Sept.—Dec.
Fimbristylis dishylla Vahl.	Aug.:
Fimbristylis digitata Boeck.	Oct.
Eleocharis capitata R. Br.	Sept.
Scirpus grossus Linn.	Sept.
Scirpus squarrosus Linn.	Oct.—Dec.
Scleria hebecarpa Nees	

Poaceae or Gramineae (Grussas)

Pennisetum hohenacekeri Hoschest exsteud.	
Setaria pollidifusca Stalf.	
Pennisetum typhoides Stalf. (Local Marathi name—Bajari).	
Setaria intermedia Roem. and Schult. Marathi name (*Pandar*).	
Setaria italica Beauv. (LN. *Rala*)	
Isachne australis R. Br.	
Tricholaena wightii Nees exsteud.	Sept.
Panicum Punctatum Burn.	Nov.
Panicum isachne Roth.	Sept.—Jan.
Panicum miliare Lamk.	
Digitaria sanguinalis Scop. var. *ciliaris* Prain	
Digitaria royleana Prain	Dec.
Paspalum compactum Linn.	Oct.
Sporobolus diander Beauv.	
Sporobolus indicus Br.	Oct.
Eragrostis viscosa Trin. Syn. *E. tenella* Woodr.	Oct.
Eragrostis interrupta Beauv. var. *Koenigii* Stapf	
Eragrostis anabilis Wt. and Arn.	Sept.—Nov.

Orchidaceae	Flowering Season
Eragrostis major Host.	Nov.—Jan.
Melanocenchrus jacquemontii Jaub syn. *Garcilea royleana* Hook. f.:	
Cynodon dactylon Pers.	Oct.-Nov.
Chloris barbata Sw.	Oct.-Nov.
Chloris virgata Swart.	Oct.-Nov.
Tripogon lisboae Stapf.	Oct.-Nov.
Eleusine indica Gaertn.	Jan.
Dactyloctenium aegypticum Willd. Syn. *Eleusine aegyptiaca* Desf.	Sept.—Nov.
Eleusine coracana Gaertn.	
Dinebra retroflexa Pazer.	Aug.
Hygrorhiza aristata Nees	April
Oryza sativa Linn.	
Oropetium thomaeu Trin.	
Bambusa arundinacea Willd. and Kult.	
Dendrocalamus strictus Nees. Willd. and cult.	
Dendrocalamus giganteus Munro	
Bambusa nana Roxb.	
Zeamays Linn.	
Triticum sativum Lam.	
Cymbopogon Cartini Stapf.	
Andropogon helepensis Brot.	Dec.
Cymbopogon montanus Trin.	Oct.-Nov.
Echinocloa colonum Link:	
Eromopogon faveolatus Stapf	Oct.-Nov.
Michrochloa indica Beauv.	
Unochola halopus Stapf.	

1·3. Aquatic Vegetation around Kolhapur :

There are a number of lakes and ponds in low lying areas around Kolhapur. In fact, Kolhapur is said to be a city of lakes and ponds, but many have not been investigated botanically. One such lake which has been investigated is the lake supplying drinking water to Kagal town, well-known as the home of the late Gopal Krishna Gokhale.

This lake known as Jaysingrao Talao of Kagal was constructed by the Kagal municipality in 1894. It is about 16 kilometres to the south of Kolhapur a little away from Pune-Bangalore road. It is about 565.7 metres above sea level, close to Kagal town. It is fringed by two hillocks on eastern and southern side, 51.2 metres long and 4.5 metres high. It is almost at the ground level on the western side. It occupies 76 acres of land and is a part of original perennial lake. It is filled by soil from the hill tops and ollurium from surrounding perennial sources of water. It maintains about 9 metres of water all the time in summer. It gets cut off into puddles in summer but maintains constant supply of water of 18" above soil in an area of 6.4 km. Soil is poor and gravelly except on the north, eastern and western border, where it is alluvial, rich in humus and clay. Average rainfall is 687 mm—812 mm and mean monthly temperature 88°F. Average relative humidity is from 83 to 63% in the morning and falls to 68-32% in the evening. The lake is full of angiosperms split into 11 plants associations. There are about 140 species.

Dicotyledons	Season	Habit	Growth Period
Capparidaceae	Seasonal ..	Erect ..	Sept.—Jun.
Cleome viscosa Linn. ..	Do. ..	Marshy ..	Jul.—Feb.
C. chelidonii Linn. ..	Do. ..	Prostrate	Jul.-Aug.
C. simplicifolia Hook. ..	Do. ..	..	Jul.-Aug.
Polygalaceae :			
Polygala chinensis Linn	..	Do. ..	Oct.—March
Portulaceae :			
Portulaca oleracea Linn.	Annual ..	Do. ..	Throughout year
Elatinaceae :			
Bergia ammannioides Roxb.	Do. ..	Marshy ..	Aug.—Oct.
Malvaceae :			
Sida acuta Burm ..	Do. ..	Do. ..	Nov.-Dec.
Tiliaceae :			
Chorchorus olitorius Linn.	Erect ..	Seasonal	Sept.—Dec.
Linaceae :			
Linum musorense Heyne	Seasonal ..	Erect ..	Oct.—Dec.
Zygophyllaceae :			
Tribulus terrestris Linn...	Annual ..	Prostrate	Throughtout year.
Fabaceae/Papilionaceae :			
Zornia diphylla Pers. ..	Seasonal ..	Do. ..	Aug.-Sep.
Heylandia latebrosa DC.	Do. ..	Do. ..	Sept.—Feb.
Crotalaria burhia Ham.	Do. ..	Erect ..	Oct.—Feb.
Indigofera linifolia Retz	Annual ..	Prostrate	July-Oct.
I. cordifolia Heyne ..	Do. ..	Do. ..	Aug.—Dec.
I. trifoliata Linn. ..	Annual ..	Prostrate	Aug.—Oct.
Alysicarpus tetragonolobus Edgew.	Seasonal ..	Erect ..	Aug.-Sept.
Aeschynomene indica Linn.	Seasonal ..	Erect ..	Aug.—Dec.
A. aspera Linn.	Seasonal ..	Erect ..	Aug.—Dec.
Smithia conferta Sm. ..			
Lythraceae :			
Ammannia baccifera Linn.	Seasonal ..	Erect-marshy	Nov.
A. multiflora Roxb. ..	Do. ..	Do. ..	Oct.-Nov.
A. salicifolia Monti. ..	Do. ..	Do. ..	Oct.—Nov.
Rotala rotundifolia ..	Do. ..	Do. ..	Oct.—Nov.
R. tenuis	Do. ..	Do. ..	Oct.—Nov.
Onagraceae :			
Ludwigia octovalvis ..	Do. ..	Do. ..	Aug.—Oct.
Cucurbitaceae:	Do. ..	Do. ..	Aug—Oct.
Citrullus colocynthis Schrad.	Do. ..	Creeping	Sept.—Dec.
Ficoideae :			
Mollugo hirta Tnom ..	Annual ..	Prostrate	Sept.-Oct.
M. pentaphylla Linn. ..	Do. ..	Do. ..	Sept.—Nov.

Dicotyledons	Season	Habit	Growth Period
Glinus oppositefolius ..	Annual ..	Prostrate	Sept.—Nov.
Trianthema monogyana Linn.	Do. ..	Do. ..	June—Aug.
Rubiaceae .			
Dentella repens Forst. ..	Seasonal ..	Do. ..	July—Oct.
Spermacoce stricta Linn.	Do. ..	Erect ..	Oct.-Nov.
S. hispida Linn.			
Oldenlandia corymbosa Linn.			
Asteraceae :			
Acanthospermum hispidum Linn.			
Xanthium strumarium Linn			
Caesulia axillaris Roxb.			
Cathocline spp.			
Glossocordialinieari folia Cass.			
Eclipta prostrata Linn.			
Echinops echinatus Roxb.			
Spilanthes acmella Murr.			
Lobeliaeae :			
Lobelia trigona Roxb. ..	Seasonal	Erect ..	Aug.—Oct.
Gentianaceae :			
Nymphoides cristatum Kunth.	Perennial	Aquatic ..	Sept.—Apr.
N. indicum Kunth ..	Do. ..	Do. ..	Sept.—Apr.
Exacum pumilum Griseb.	Seasonal	Erect ..	Aug.-Sept.
E. pedunculatum Linn. ..	Do.	Do. ..	Dec.
E. lawii C. B. Clarke ..	Do. ..	Do. ..	Oct.
Centaurium centaurioides	Do. ..	Do. ..	Sept.—Apr.
Canscora diffnea R. Br.	Do.	Do. ..	Oct.—Jan.
C. decurrens	Do. ..	Do. ..	Oct.—Dec.
C· concanensis Clarke ..	Do. ..	Do. ..	Aug.—Oct.
Boraginaceae .			
Heliotropium ovalifoliumr Fork.	Do. ..	Prostrate	Jan.-Feb.
Coldenia procumbens Linn.	Do. ..	Do. ..	Sept.-Oct.
Sericostoma pauciflorum Stocks.	Do. ..	Do. ..	Nov.-Dec.
Trichodesma indicum R. Br	Do. ..	Erect ..	Aug.—Oct.
Convolvulaceae :			
Merremia emarginata Hali.	Perennial	Prostrate	Sept.-Oct.
Solanaceae			
Solanum nigrum Linn...	Annual ..	Erect ..	Sept.—Jan.
S. xanthocarpum Schd.	Do. ..	Prostrate	June—August

Dicotyledons	Season	Habit	Growth Period
Scrophulariaceae :			
Bacopa monniera (L) Wettst.	Annual	Erect Prostrate	June—Jan.
Celsia coromandeliana Vahl.	Do.	Erect	Jan.—Oct.
Sutera dissecta Roth.	Do.	Do.	Sept.—Feb.
Stemodia viscosa Roxb.	Do.	Do.	Sept.—Dec.
Sopubia delphinifolia G. Don.	Do.	Do.	Aug.—Oct.
Striga densiflora Benth.	Do.	Do.	Aug.—Nov.
S. euphrasioidea Benth.	Do.	Do.	Aug.—Nov.
Limnophila heterophylla Woods.	Do.	Amphibious	Oct.—Nov.
Acanthaceae :			
Hygrophila auriculata	Do.	Erect-Marshy.	Jun.—Jan.
Lepidogathis cristata Willd.	Seasonal	Prostrate	Oct.—Mar.
Rungia linifolia Nees.	Annual	Sub-erect	Oct.—Dec.
Verbenaceae :			
Phyla nodiflora (L.) Green. (—*Lippia nodiflora*)	Do.	Prostrate	All the year.
Labiateae :			
Lavendula burmanni Benth.	Seasonal	Erect	Oct.-Nov.
Leucas lavendulaefolia J. E. Sm.	Annual	Do.	Sept.—Nov.
Ocimum americanum Linn.	Do.	Do.	Aug.—Oct.
O. sanctum Linn.	Do.	Do.	Aug.—Oct.
Nyctaginaceae :			
Boerhaavia diffusa Linn.	Do.	Prostrate	Aug.—Nov.
Amaranthaceae :			
Amaranthus viridis Linn.	Do.	Erect	..
A. spinosus Linn.	Do.	Do.	Sept.
Gomphrena celosioides	Do.	Do.	Nov.-Dec
Alternanthera sessilis Lamk.	Do.	Prostrate	July—Jan.
Polygonaceae :			
Polygonum plebejum R. Br.	Do.	Do.	July—Dec.
Euphorbiaceae			
Euphorbia hirta Linn.	Do.	Do.	All the year.
Chrosophora prostrata Dalz.	Seasonal	Do.	Aug.—Nov.
Phyllanthus niruri Linn.	Do.	Do.	July—Aug.
Monocotyledons :			
Hydrocharitaceae :			
Hydrilla verticillata Prest.			Dec.

Dicotyledons	Season	Habit	Growth Period
Vallisneria spiralis Linn.	Annual ..	Prostrate..	Sept.—May.
Blyxa roxburghii Rich.	Do. ..	Do. ..	Feb.
Orchidaceae :			
Habenaria grandiflora Lindl.	Perennial	Erect ..	July
H. longicorniculata Blater and McC.	Do. ..	Do. ..	Sept.-Oct.
Eulophia pratensis Lindl.	Do. ..	Do. ..	Nov.—Feb.
Liliaceae :			
Scilla hyacinthia (Roth) Bc. Br.	Do. ..	Do. ..	July—Sept.
Urginea indica Kunth ..	Perennial	Do. ..	Feb.-March
Chlorophytum laxum R. Br.	Do. ..	Do. ..	July-Aug.
Commelinaceae :			
Cyanotis tuberosa Schult.	Do. ..	Creeping	Aug.-Sept.
C. fasciculata	Seasonal	Erect ..	July—Dec.
Typhaceae :			
Typha angustata Borg.	Perennial	Amphibious	Aug.
Potamogetoniaceae :			
Potamogeton indicus Roxb.	Annual ..	Aquatic ..	Sept.—Dec.
P. perfoliatus L. ..	Do. ..	Do. ..	Dec.—Feb.
Najadaceae :			
Najas minor All. ..	Do. ..	Do. ..	Aug.
Eriocaulaceae :			
Eriocaulon dianae Fyson:	Seasonal	Erect Marshy.	Aug.-Sept.
Cyperaceae			
Cyperus globosus All. ..	Auunal ..	Erect-Marshy	Aug.-Sept.
C. pumilus L.	Do. ..	Do. ..	Sept.
C. tegetum Roxb. ..	Perennial	Do. ..	Aug.-Sept.
C. iria L.	Annual ..	Do. ..	Oct.—Dec.
C. malabarius C. B. Cl.	Do. ..	Do. ..	Aug.-Sept.
C. pygmaeus Rottb. ..	Do. ..	Do. ..	Sept.-Oct.
C. castuneus Wild. ..	Do. ..	Do. ..	Oct.—Dec.
C. uncinatus Poir ..	Do. ..	Do. ..	Sept.—Dec.
C. flavidus Retz.: ..	Do. ..	Do. ..	Aug.-Sept.
C. aristatus Roxb. ..	Do. ..	Do. ..	Aug.-Sept.
C. eleusinoides Kunth. ..	Do. ..	Do. ..	Sept.
Scirpus littoralis Schrad	Do. ..	Do. ..	Aug.—Oct.
Eleocharis bistulosa Link	Do. ..	Do. ..	Sept.
E. atro-purpurea Kunth.	Do. ..	Do. ..	Sept.
Fimbristylis guinguangularis	Do. ..	Do. ..	Aug.-Sept.
F. tetragona R. Br. ..	Do. ..	Do. ..	Aug.-Sept.
Fimbristylis dichotoma Vahl.	Do. ..	Do. ..	Sept.-Oct.
F. monostrchya Hask ..	Do. ..	Do. ..	July-Aug.
F. woodrowii C. B. C.l	Do. ..	Do. ..	Aug.—Oct.

Dicotyledons	Season	Habit	Growth Period
F. tenera Schult. ..	Perennial	Erect-Marshy	Sept.
F. diphylla Vahl. ..	Annual ..	Do. ..	Aug.
F. spathacea Roth. ..	Do. ..	Do. ..	Aug.-Sept.
Cyperus triceps Rottb.	Do. ..	Do. ..	Aug.-Sept.
Fuierena wallichiana Kunth.	Do. ..	Do. ..	Aug.-Sept.
Rhynchospora wallichiana Kunth.	Do. ..	Do. ..	Aug.
Poaceae (Gramineae)			
Saccharum spontameum L.	Perennial	Do. ..	Sept.—Oct.
Cymbopogon martini Roxb.	Do. ..	Do. ..	Dec.—Apr.
Paspalidium geminatum Staf.	Do. ..	Floating-	Oct.—Mar.
Erogrostis interrupta Beauv.	Do. ..	Erect-Marshy.	Feb.-Mar.
Cenchrus Sp.	Do. ..	Do. ..	Feb.-Mar.
Isachne elegans Dalz. ..	Do. ..	Do. ..	Dec.—Mar.
Arundinella Sp. ..	Do. ..	Do. ..	Feb.
Echinochloa colona L. ..	Do. ..	Erect- .. Aquatic.	Oct.—Mar.
Sporobolus Sp. ..	Do. ..	Erect-Marshy	Oct.

1.4. *Plants of Radhanagari Forest and Bhogavati River Bed* :

The main forests of Kolhapur where a large number of plants are concentrated lie to the west and south-west of Kolhapur. It is a strong hilly region and extends through Chandagad to Padgaon forests. The average rainfall varies from 35″ to 300″. Chandagad range is very rich in plants. Naturally the vegetation there is quite dense. Radhanagari lies at 16° 30′ North and 74° East. Altitude of the Radhanagari taluka varies from 549 m to 915 m (1800—3000). The slopes are steep. Sometimes even 365.7 m high. Especially they are so in the southern region. The table-land on the mountain gets maximum rain. There are a number of offshoots from the north-eastern ranges of Sahyadris. The small rivers like Dhamani and Tulsi, and large rivers like Bhogavati and Doodhganga flow through the hilly region. The lead of Bhogavati river is turned into a huge zigzag lake having an area of 1641 hectares., called Marmitalav built in 1951. Another lake is being constructed to the south of Radhanagari on Doodhganga river. The soil is lateritic, shallow and poor because of high precipitation and erosion. During monsoon it is over saturated with water. But soon after the monsoon it completely dries up. Bauxite is found at many places near about and is known to be not a very good promoter of plants. Mean maximum temperature in summer in May is 37.°22°C and minimum 21°.11°C, the humidity then being 20—50 per cent. During monsoon it goes up to 90—100 per cent as the temperature falls in July. In autumn in November mean maximum temperature is about 26°.66°C and minimum 12°—22°C respectively, humidity being 60—80 per cent. Temperature falls to 21°.68°C in January and 16°.11°C. Mean maximum humidity 20—40 per cent. Rainfall due to south-west monsoon is quite high, 3810 mm. (152″). Dajipur—Gaganbavada range lies to its west. The rainfall however abruptly comes down to 2540 mm within a distance of 16 km. to the east.

The forest is evergreen. It contains tall trees but here the intensity of light is low. There are barren lands and patches of deciduous forests and even scrub on the eastern parts of Radhanagari forest due to human interference. In the previous regime grass and forest were preserved and a game sanctuary for large animals like bison, bear, boar and tiger was created. Birds also lived to the north of Radhanagari. Towards the west there are sub-tropical forests known as Dangs where many plants are preserved in Dev Raies. They have been described by Sharma and Kulkarni (1981).

The vegetation here is evergreen in the hilly regions and in deep valleys. Dangs have sub-tropical forests. A special feature of vegetation is two layers of canopy. The under-growth is not much, but wherever it occurs it is abundant. The upper canopy consists of trees of *Syzygium cumini, S. hemisphericum, Lagerstroemia parviflora, Actinodaphne hookeri, Litsea Stocksii, Cinnamomum zeylanicum, Nephalium longana, Holigarna grahami, Ochrocarpus longifolius, Garcinia indica, Eleocapups oblongus, Amoora lawii, Alstonia scholaris, Symplocos beddomei, Ficus glomerata* and *Hymenodictyon obovatium*. The second canopy consists of *Memecylon umbellatum, Mappia foetida, Clausena indica, Syzygium zeylanicum, S. caryophyllatum, Ixora nigricans, Diospyros candollana, Linociera malabarica, Olca dioca, Glochidion hohenackeri*. Where the soil has shade below, shrubs of *Grewia levigata, Gymnosporia rothiana, Lasiosiphon eriocephalus, Leea macrophylla, Casearia graveolens, Pogostemon parviflorus, Mallotus stenanthus* are found. Outside the thick growth of shrubs of *Carvia callosa, Strobilanthes sessilis, Impatiens latifolia, I. pulcherrima, Crotolaria retusa, Solanum giganteum, Gallicarpa lanata, Lobelia nicotianaefolia, Maesa indica, Rauwolfia densiflora, Justicia betonica, Vitex negundo, Ficus hispida, Pteridium aquilinum, Habenaria longicalcarata, Platanthera sussannae, Curcuma psuedomontana, Osbeckia truncata, Begonia crenata* are common, besides several grasses like *Eragrostis amabilis, Themeda quadrivalvis, Aristida setacea, Setaria glauca, Aristida setacea, Apluda aristata, Paspalum compactuam*. Many climbers like *Clematis malabarica, C. gouriana, Gnetum ula, Capparis moonii, Scutia indica, Vitis pentaphylla* may be mentioned. Outside the shruby layer, *Calycopteris floribunda, Rubia cordifolia, Piper hookeri, Smilax macrophylla, Calamus pseudotenuis* and *Asparagus racemosus* are common. In denuded areas and in open places dry deciduous plants are found, *Carissa carandas*. This Comprises dry deciduous type of vegetation *Tectona grandis, Anogeissus latifolia. Woodfordia fruticosa* and grass. The Radhanagari forests are similar to forests of Padgaon and Dajipur and are quite rich in plants. They provide good timber in the Chandagad area and also fuel from species other than *Tectona grandis*. They contain tropical evergreen plants and also some semi-evergreen and dry habitat plants. Many of them are also found in Goa, North Canara and Malabar forests. It is quite a good representative of evergreen forest in Maharashtra. It is richer than Khandala in plant species. There are many medicinal plants also. The area compares well with Sawantwadi area. The list of plants found in Radhanagari forests and Bhogavati river bed collected by Prof. S. A. Parandekar is given here. It may be compared with similar list of Padgaon and Khandala plants which will show the richness of the flora here.

Enumeration of plants from Radhanagari dam area and along the bed of Bhogavati river :—

Ranunculaceae:

Clematis gourinana

A-127—36-A.

Papavaraceae :
Argemone mexicana

Malvaceac :
Sida veronicifolia
Kydia calycina
Bombax malabaricum

Malpighiaceae :
Hiptage madablota

Geraniaceae :
Oxalis corniculata

Olacaceae :
Mappia foetida

Vitaceae :
Leea latifolia

Papilionaceae :
Cylista scariosa
Dalbargia volubilis
Derris scandens

Menispermaceae :
Stephania hernandifolia
Cyclea busmanni
C. peltata

Sterculiaceae :
Helicteres isora

Tiliaceae :
Erinocarpus nimmennii
Triumfetta pilosa
T. rhomboidea

Rhamnaceae :
Zizyphus rugosa

Anacardiaceae :
Anacardium occidentale
Semicarpus anacardium
Holigarna grahami

Mimosaceae :
Acacia
Acacia concinna

Combretaceae :
Terminalia bellerica
T. paniculata

Myrtaceae :
Eugenia lanceolata
E. corymbosa

Turneraceae :
Turnera ulmifolia

Rubiaceae :
Anthocephalus indicus
Mitragyna parvifolia
Wendlandia notoniana
Oldenlandia corymbosa
Randia dumetorum
Gardenia lucida
Vangueria spinosa
Pavetta indica

Apocynaceae :
Plumeria acutifolia
Carissa carandas
(*C. congesta*)

Caesalpineae :
Wagatea spicata
Cassia fistula
Bauhinia Sp.
Ammania multiflora
Woodfordia fruticosa

Umbelliferae :
Carum stictocarpum
Hydrocotyle asiatica

Compositae :
Senecio edgeworthii
Sphaeranthus indicus
S. africanus
Eclipta erecta
Elephantopus scaber
Tricolepis glaberrima

Oleaceae :
Jasminum malabaricum

Asclepiadaceae :
Hemidesmus indicus
Cryplolepis buchanani

Gentianaceae :
Erythraea roxburghii
Canscora diffusa
Canscora decurens

Solanaceae :
Solanum indicum

Acanthaceae :
Blepharis asperrima
Asteracantha longifolia
Daedalacanthus roseus
Strobilanthes callosus
Haplanthus tentaculalus
Lapidagathis cristata
Rungia parviflora var *pectinata*
justicia betonica

Amarantaceae :
Achyranthus aspera

Polygonaceae :
Polygonum chinensis

Thymeliaceae :
Lasiosiphon eriocephalus

Loranthaceae :
Loranthus longiflorus

Asclepiadeceae :
Asclepias curasavica

Hydrophyllaceae :
Hydrolea zeylanica

Convolvulaceae :
Argyreia speciosa

Lentibulariaceae :
Utrcularia coerulea

Verbenaceae :
Lantana camara
Callicarpa lanata
Tectona grandis
Vitex negundo
Clerodendron serratus

Labiatae :
Pogostemon parviflorus
Dysophylla stellata
Colebrookea oppositifolia
Leucas stelligera
Leucas ciliata
Pogostemon purpurascens

Urticaceae :
Ficus religiosa L.

Orchidaceae :
Vanda roxburghii 1 Br.
Aerides crispum Lindl.

Dioscoreaceae :
Dioscorea hispide

Liliaceae :
Smilax macrophylla Roxb.

Typhaceae :
Typha augustata Bory.

Euphorbiaceae :
Bridelia stipularis Bl.
Phyllanthus emblica L.
Jatropha curcas L.
Homonoia riparia Lour.
H. retusa Muell

Pandanaceae :
Pandanus furcatus Roxb.

Eriocauliaceae :
Eriocaulon sp.

1·5. Plants of Padgaon Forest :

Another important area in Kolhapur district where there is plenty of vegetation is Padgaon in Bhudargad taluka. There is good forest and the plants found here are given below through courtesy of the late Professor S. A. Parandekar. The vegetation is easily comparable with that of Radhanagari, Mahabaleshwar or Khandala. Radhanagari and Padgaon forests form typical pockets of evergreen forests. This list is worthy of note for the following evergreen species and some moist deciduous plants such as *Leea sambucina, Dillenia indica, Crotolaria retusa, Garcinia indica* and *Gardenia malbaricum, Ochocarpus longifolius, Mesua ferreia, Mappia foetida, Salacia pironoides, Holigarna arottiana, Nothopegia, Colobrookia, Lobelia nicotianaefolia, Symplocos beddomii, Ixora nilgireans, Ligustfrum nilgiriensis var ovata. Oxoxylum indicum, Hydnocarpus, wightrana Piler nigrum, (Cinamomum zeylanicum, Eleagnus latifolia, Bryonia pilrea.) Macranaga roxburghii, Sapium insigne, Salix tetrasperma.*

Enumeration of Important Plants in Padgaon Forest

Ranunculaceae :
Clematis gouriana Roxb.

Magnoliceae :
Michelia champaca L.

Papavaraceae :
Argemone mexicana L.

Cappridaceae :
Capparis moonii

Bixaceae :
Flacourtia montana Grah.

Malvaceae :
Sida rhombifolia Mast.
Urena lobata
Hibiscus furcatus
Abutilon polyandrum
Bombax malabaricum

Rutaceae :
Xanthoxylum triphyllum Wt.
Glycosmis pentaphylla
Murraya exotica
Luvunga eleutherandra:
Atalantia monophylla:

Rhamnaceae:
Zizyphus rugosa

Vitaceae :
Vitis elongata
V. trifolia
Leea sambucina

Moringaceae :
Moringa pterygosperma

Cannaraceae :
Cannarum strictum

Papillionaceae : :
Heylandia latebrosa
Crotolaria retusa

Dilleniaceae :
Dillenia indica

Menispermaceae :
Cocculus macrocarpus
Stephania hernandifolia
Cyclea burmanni

Guttiferae :
Garcinia indica
Garcinia malabarica
Ochrocarpus longifolius
Mesua ferrea

Sterculiaceae :
Sterculia villosa

Tiliaceae :
Grewia sp.
Triumfetta rhomboidea
Elaeocarpus munroii

Meliaceae :
Dysoxylum binectariferum

Oleaceae :
Mappia foetida

Celastraceae :
Celastrue paniculata
Gymnosporia rothiana
Salacia prionoides

Sapindaceae :
Allophylnus cobbe
Hemigyrosa canescens

Anacardiaceae :
Mangifera indica
Anacardium occidentale:
Holigarna arnottiana
Nothopegia colebrookiana
Spondias mangifera

Caeselpineae :
Cassia fistula

Papillionaceae :
Erythrina indica
Butea frondosa
Atylosia lineata
Cylista scariosa
Flemingia bracteata
Dalbergia latifolia
D. volubilis

Myrtaceae :
Eugenia lanceolata
E. heyneana
E. jambos
Careya arborea

Samydaceae :
Casearia graveolens

Umbelliferae:
Carum stictocarpum
Hydrocotyle asiatica

Compositae :
Elephantpus scaber
Cyathocline lyrata
Sphaeranthus indicus
Senecio edgeworthii
Tricholepis glaberrima

Lobeliaceae :
Lobelia nicotiananefolia

Myrsinaceae :
Maesa indica
Embelia robusta
Ardisia solanacea

Styraceae :
Symplocos spicata

Apocynaceae :
Carissa congesta
Wrightia tomentosa
Tabernaemontana crispa
Plumeria acutifolia
Cerbera thevetia

Caesalpineae :
Cesalpinia nuga
Wagatea spicata
Bauninia sp.
Acacia pennata

Crassulaceae :
Bryophyllum calycinum

Rhizophoraceae :
Carallia integerrima:

Combretaccae :
Terminalia chebula
Terminalia bellerica

Terminalia tomentosa
Terminalia paniculata

Melastomaceae :
Memecylon edule

Lythraceae :
Lagerstroemia lanceolata

Cucurbitaceae :
Melothria heterophylla

Araliaceae :
Heptapleurum venulosum

Rubiaceae :
Oldeniandia corymbosa
Wendlandia notoniana
Mussaenda frondosa
Randia dumetorum
Vangueria spinosa
Ixora nigricans
Pavetta indica
Rubia cordifolia
Canthium umbellatum

Sapotaceae :
Sideroxylon tomentosum

Oleaceae :
Jasminum malabaricum
Lonicera intermedia var. roxburghii
Lingustrum neilgherrense var. *ovata*

Asclepiadaceae :
Hemidesmus indicus
Hoya wightii
Daemia extensa

Gentianaceae :
Exacum bicolor
Canscora diffusa
Erythraea roxburghii

Bigoniaceae :
Oroxylum indicum
Stereospermum chelonoides:

Verbenaceae :
Lantana camara
Callicarpa lanata
Tectona grandis
Vitex negundo
Clerodendron serratus

Polygonaceae :
Polygonum chinensis

Podostemonanceae :
Hydrobryum lichenoides

Piperaceae
Piper nigrum

Lauraceae :
Cinnamomum zeylanicum

Elaeagnaceae :
Elaeagnus latifolius

Euphorbiaceae :
Euphorbia ligularia
Bridelia stipularis
Bridelia retusa
Bischofia javanica
Glochidion hohenackeri
Breynia patens
Macaranga roxburghii
Homonoia riparia
Tragia involucrata
Sapium insigne
Pedilanthus tithymaloides

Salicaceae :
Salix tetrasperma

Boraginanceae :
Cordia myxa

Convolvulaceae :
Ipomoea companulata

Solanaceae :
Solanum indicum

1.6. Important Plants of Gaganbavada :

Gaganbavada is the headquarters of Gaganbavada taluka, about 112 km NW of Kolhapur, and about 40 km further of Radhanagari. Part of it abutts on the edge of Sahyadri, but its greater part lies on Desh side. It is surrounded by hills which get dried up after rains. There are a few moist deciduous species like *Garcinia xanthochymus* but they are mixed with many dry deciduous plants. The vegetation is mixed deciduous. The place is much isolated from the rich evergreen vegetation of Radhanagari. There are a large number of plants of *Terminalia chebula, Vangueria spinosa, Terminalia bellerica, T. paniculata,* shrubs of *Strobilaenthes perfoliantus, Mappia foetida,* small stunted trees of *Memecylon edule, Lasiosiphon eriocephalus, Scutia indica, Calycoteris floribunda* etc. *Capparis moonii, Nothopegia colebrookeana, Hura eriptans, Eleagnus latifolia.* These are remarkable. With Phonda ghat on the north and Amboli down south, the place is full of plants, but all in isolated patches. *Sapindus laurifolius* and *Celastrus paniculata* are common. The vegetation is more or less like that of Bhaja or Karla behind the high rainfall zone of Khandala. Its mixed character is well brought out by the list of plants of Gaganbavada supplied by the late Prof. S. A. Parandekar. The main approach road to it is from Rankala at Kolhapur and there is

one *kutcha* road also from Amba ghat top. The road gets washed away during rains. The area provides several thousands of bags of myrobalans to the Amba tannin factory at Amba. Some ground orchids are found on forest floor in shady places.

Plants of Gaganbavada

Rannuncalaceae :
Clematis gouriana Roxb.

Capparidaceae :
Capparis spinosa L.
C. moonii Wt.

Guttiferae :
Garcinia xanthochymus Hk. f.

Malvaceae :
Hibiscus furcatus Willd.
Bombax malabaricum DC.
Abutilon polyandrum W. and A.

Tiliaceae :
Erinocarpus nimmonii Mochst.
Grewia microcos L.

Rutaceae :
Murraya koenegii Spr.
Glycosmis pentaphylla Corr.
Atlantia monophylla DC.

Oleaceae :
Mappea foetida Miers

Celastraceae :
Celestrus paniculatus Willd.

Rhamnaceae :
Scutia indica Brongn.
Sapindus laurifolius Vahl.

Anacardiaceae :
Nothopegia celebroockiana Bl.
Manglfera indica L.

Leguminosae :
Wagatea spicata Dalz.
Erythrina indica Lam
Butea monosperma Konig.
Alysicarpus longifolius W. and A.

Rhizophoraceae :
Carallia integerrima DC.

Combretaceae :
Cambretum ovalifolium Roxb.
Terminalia bellerica Roxb.
T. chebula Retz
T. paniculata Roth.

Myrtaceae :
Eugenia jambolana Law

Melastomaceae :
Memecylon edule Roxb.

Lythraceae :
Woodfordia fruticosa Salisb.

Umbelliferae :
Carum strictocarpam Clarke

Rubiaceae :
Cantheum umbellatum Wt.
Ixora nigricans Br.
Vanqueria spinosa Roxb.
Plectronia rheedei Bedd.
Randia dumetorum Lam.
(= *Xeromphis spinosa*):

Compositae :
Cyathocline lyrata Cass.

Myrsinaceae :
Maesa indica Wall.

Apocynaceae :
Tabernaemontana crispa Dalz.
Carissa congesta L.

Asclepidaceae :
Calotropis gigantea

Solanaceae :
Solanum indicum L.

Scrophulariaceae :
Limnophylla heterophylla Woodr.

Bignoniaceae :
Heterophragma roxburghii DC.

Acanthaceae :
Strobilaenthes perfoliatus T. Anders
Lepidagathis lutea Dalz.
Asteracantha longifolia Nees
Haplanthus verticilltus Nees

Verbinaceae :
Vitex negundo L.

Labiatae :
Pogostemon parviflorus Bth.
Leucas stelligera Wall.
Pysophylla stellata Bth.

Amarantaceae :
Aerua scandens Wall.

Polygonaceae :
Polygonum chinense Grah.

Podostomaceae :
Podostemon Sp. (?)

Thymeleaceae :
Lasiosiphon eriocephalus Dene

Euphorbiaceae :
Macaranga roxburghi Wf.
Eleagnus latifolius L.
Gymnosporia montana Benth.
G. rothiana Law
Glochidium hohenackeri Bedd.

Orchidaceae :
Dendrobium barbatum Lind.
Vanda roxburghii Br.

Liliaceae :
Asparagus racemosus L. var. *gavanica* Baker

Palmae :
Phoenix sylvestris Roxb.

1·7. Dev-Raies in Kolhapur District :

Near Radhanagari area there is a 'Dev-Rai' or simply called 'Rai' which has been studied by Sharma and Kulkarni (1980). These Dev Raies are peculiar conserved sacred groves of plants, generally trees, in western ghats. People are prohibited, under the fear of curse from God or Deity of the Rai, cutting any tree or other plants in Dev Raies. There are about 250 such Dev-Raies all along the Western Ghats. Most of them contain a small number of evergreen, some semi-evergreen moist deciduous and some dry deciduous plants. For example *Clausena indica, Evonymus indica, Naravelia zeylanica, Persea gratissima, Holigarna grahamii, Luvunga sarmentosa, Syzygium hemisperma* are evergreen. *Strychnos maximia, Olax wightiana, Garoinia talbotii, Prunus zeylanica, Salacia macrosperma* are semi-evergreen and others are deciduous.

The vegetation that they represent is entirely different from that in the surrounding area. In Kolhapur district there are a number of Raies : one each in Gaganbavada, Radhanagari, Gargoti, Ajra and two-three in Chandagad taluka. Most of them lie in the catchment area of the Ghats. Many plants they contain are not to be seen in the surrounding nearby areas which are dry deciduous.

They have variable rainfall, more than 6700 mm at Gaganbavada, 1750 mm at Chandagad, about 1800 mm at Radhanagari. Other Raies mentioned by Sharma and Kulkarni (1980) are at Nerveli, Teliya Rai at Gaganbavada, one at Gargoti etc. Raies in Western Ghats were studied by Gadgil and Vartak (1975-1976).

Some rare plants, medicinal or endemic, are found in Raies e.g. *Gnetum ula, Salacia macrosperma, Entada pursaetha*, etc. All these Raies deserve full investigation. Raies in Chandagad, Gargoti, Hanuman-Ghat, Raies at Kitwade, Ajra, Asangaon, Ambabaichi Rai of Radhanagari are very famous and deserve critical survey and study.

They represent the relict or ancient tropical type of forest vegetation of the late Eocene period. They might have disappeared later due to subsequent changes in the climate in Miocene and Pleistocene periods, less rainfall and dryness. On account of less raintall and hot temperature in Miocene and low temperature and cold waves in Pleistocene plants died. They were revived to their present status after the Quaternary period.

	Botanical name	Local name	Remarks*
	RANUNCULACEAE :		
1.	*Clematis gouriana* Roxb. ..	Morvel	Sem.
2.	*Naravelia zeylanica* (L.) DC.	Nakchini ..	R., Sem.
	ANNONACEAE :		
3.	*Uvaria narum* (Bl.) Dunal ..	Saplilvel	Ev.
	MENISPERMACEAE:		
4.	*Diploclisia glaucescens* (Bl.) Diels.	Remark ..	Sem.
	CAPPARACEAE :		
5.	*Capparis moonii* Wt.	Waghati	Sem.
	FLACOURTIACEAE :		
6.	*Casearia esculenta* Roxb. ..	Modi	Sem.
7.	*Hydnocarpus pentandra* (F. Ham.) Oken.	..	Sem.
	CLUSIACEAE :		
8.	*Garcinia talbotii* Raiz. ex. Sant.	Haldi	Sem.
9.	Mammea suriga (Buch. Ham. ex Roxb) Kosterm.	Surangi	Ev. Ec.
	ANCISTROCLADACEAE :		
10.	*Ancistrocladus heyneanus* Wall. ex Grah. ..	Karotal	Sem.
	MALVACEAE :		
11.	*Sida rhombifolia* L.	Bala, Jangli methi	MD.
12.	*Urena lobata* L.	Van-Bhendi ..	MD.
	STERCULIACEAE :		
13.	*Sterculia guttata* Roxb. ..	Goldar.	Sem.
	TILIACEAE :		
14.	*Erinocarpus nimmonii* Grah. ex Dalz and Gibs.	Chera ..	MD.
15.	*Grewia umbellifera* Bedd. ..	.. ..	Sem.
16.	*Microcos paniculata* L. ..	Hasoli, Asolin ..	MD
17.	*Triumfetta rhomboidea* Jacq.	.. ..	Sem.
	ELAEOCARPACEAE :		
18.	*Elaeocarpus serratus* L.	Perinkan ..	Ev.
	MALPIGHIACEAE :		
19.	*Hiptage benghalensis* (L.) Kurz	.. ..	Sem.

*Ec=Economic Importance, Ev=Evergreen, Sem=Semi-evergreen, Med=Medicinal, C=Common, D=Dominant.

	Botanical name	Local name	Remarks
	RUTACEAE :		
20.	*Atalantia racemosa* Wt. and Arn.	Makadlimbu ..	Sem.
21.	*Clausena indica* (Dalz) Oliv. ..	.. ..	Ev.
22.	*Euodia lumu-ankenda* (Gaertn) Merr.	Bok	Ev.
23.	*Luvungasarmentosa* (Bl.) Kurz.	Aklan	Ev.
24.	*Paramignya monophylla* Wt. ..	Makadi	Sem.
25.	*Xanthoxylum rhetsa* (Roxb) DC.	Tirphal	MD., Med.
	MELIACEAE :		
26.	*Aglaia lawii* (Wt.) Saldanha ..	Kat, Burumb ..	Ev.
27.	*Dysoxylum binectariferum* (Roxb.) Hook. f. ex Bedd.	Kauti, Yerindi ..	Sem.
28.	*Trichilia connaroides* (Wt. and Arn.) Benth.	Limbara	Sem.
	OLACACEAE :		
29.	*Olax wightiana* Wall. ex Wt. and Arn.	.. ..	MD.
	ICACINACEAE :		
30.	*Nothopodytes foetida* (Wt.) Sleum.	Amartya ..	Sem.
	CELASTRACEAE :		
31.	*Celastrus paniculatus* Willd...	Kangun	MD., Med.
32.	*Euonymus indicus* Heyne ex Wall.	Sarpin	Ev., R.
33.	*Hippocratea grahamii* Wt. ..	Lokhandi ..	Sem.
34.	*Salacia macrosperma* Wt. ..	Dhavsi	Sem., Med.
	RHAMNACEAE :		
35.	*Scutia myrtina* (Burm. f.) Kurz.	.. ..	Sem.
36.	*Ventilago bombaiensis* Dalz.	.. ..	Sem.
37.	*Zizyphus rugosa* Lamk. ..	Toran	MD.
	VITACEAE :		
38.	*Cissus woodrowii* (Stapf ex Cooke) Sant.	.. ..	MD.
	LEEACEAE :		
39.	*Leea indica* (Burm. f.) Dinda Merr.	.. ..	MD.
	SAPINDACEAE :		
40.	*Allophlyus cobbe* (L.) Racusch.	Tipan	MD.
41.	*Lepisanthes tetraphylla* (Vahl) Radlk.	Karpa	Sem.
	ANACARDIACEAE :		
42.	*Holigarna grahamii* (Wt.) Kurz.	Ranbiba	Ev.
43.	*Mangifera indica* L.	Amba	Sem. Ev.
44.	*Nothopegia racemosa* (Dalz.) Ramam.	Ambeti	MD.

	Botanical name	Local name	Remarks
	CONNARACEAE :		
45.	*Connarus wightii* Hook. f. ..	Phat-phati ..	MD.
46.	*Rourea praineana* Talb. ..	.. ..	Sem.
	FABACEAE :		
47.	*Crotolaria retusa* L.	Khulkhula, Ghagri	MD.
48.	*Mucuna monosperma* DC. ..	Songyra	MD.
49.	*M. pruriens* Hook.	Khajkuily ..	MD.
50.	*Rhynchosia hirta* (Andr.) Meikle and Verdc.	.. ..	Sem.
	CAESALPINIACEAE :		
51.	*Wagatea spicata* Dalz. ..	Wakeri	Sem., Med.
	MIMOSACEAE :		
52.	*Acacia sinuata* (Lour.) Merr.	Shikekai	Sem.
53.	*Entada pursaetha* DC. ..	Garbi	Sem.
	ROSACEAE :		
54.	*Prunus zeylanica* (Wt.) Miq.	Uvala	Sem.
	CRASSULAEAE :		
55.	*Kalanchoe pinnata* (Lamk.) Pers.	Ghaymari ..	MD.
	RHIZOPHORACEAE :		
56.	*Carallia brachiata* (Lour.) Merr.	Phansi	Sem.
	COMBRETACEAE :		
57.	*Combretum latifolium* Bl. ..	Haladvel ..	Sem.
58.	*Terminalia bellerica* (Gaertn.) Roxb.	Hela	Sem., Med.
59.	*T. crenulata* Roth	Ain	MD. Ec.
	MYRTACEAE :		
60.	*Syzygium cumini* (L.) Skeels	Jambhul	MD., Ec.
61.	*S. hemisphericum* (Walp) Alston.	Jabalaz	Ev.
	MELASTOMATACEAE :		
62.	*Memecylon umbellatum* Burm.	Anjan	Sem., Ec.
	LYTHRACEAE :		
63.	*Lagerstroemia microcrapa* Wt.	Nana	Sem. Ec.
	CUCURBITACEAE :		
64.	*Solena heterophylla* Lour. ..	Gometi	Med.
	ARALIACEAE :		
65.	*Schefflera venulosa* (Wt. and Arn.) Harms.	Waghchawad ..	Sem., Ec.
	RUBIACEAE :		
66.	*Canthium angustifolium* Roxb.	Shengali	Med.
67.	*Ixora brachiata* Roxb. ..	... ..	Med.
68.	*I. niigricans* R. Br. ex Wt. and Arn.	.. ..	Sem.
69.	*Meyna laxiflora* Robyns ..	Helu, Alu ..	MD.

	Botanical name	Local name	Remarks
70.	*Mussaenda glabrata* (Hook. f.) Hutch.	Bhutkes	MD.
71.	*Randia rugulos* (Thw.) Hook. f.	Travelz	Sem.
72.	*Xeromphis spinosa* (Thunb.) Keay.	Gela, Kumbhal	MD. Med.
	ASTERACEAE :		
73.	*Ademostemma lavenia* (L) O. Kuntze.		Sem.
74.	*Ageratum conyzoides* L.		MD.
75.	*Blumea solidaginoides* (Poir.) DC.		MD.
76.	*B. virens* DC.	Haran	MD.
77.	*Elephantopus scaber* L.		MD.
78.	*Vernonia divergens* (Roxb.) Edgew.		Sem.
	MYRSINACEAE :		
79.	*Ardisia solanacea* (Poir) Roxb.		MD.
	SAPOTACEAE :		
80.	*Mimusops elengi* L.	Bakul	Sem.
81.	*Xantolis tomentosa* (Roxb.) Raf.		MD.
	EBENACEAE :		
82.	*Diospyros candolleana* Wt.		Sem.
83.	*D. oocarpa* Thw.		Ev., R.
	SYMPLOCACEAE :		
84.	*Symplocos racemosa* Roxb.	Dhamu, Lodhya	Sem.
	OLEACEAE :		
85.	*Jasminum malabaricum* Wt.	Kusar	MD.
86.	*J. rottlerianum* Wall. ex A. DC.		MD.
87.	*Ligustrum perrottatii* A. DC.	Kunjan, Kapshi	Sem.
88.	*Linociera malabarica* Wall. ex G. Don.		Sem.
89.	*Olea dioica* Roxb.	Pajarabhul	Sem., Ec.
	APOCYNACEAE :		
90.	*Aganosoma cymosa* (Roxb) G. Don.	Sapli	Sem.
91.	*Agnodendren paniculatum*	Dik-vel, Dudurni	MD.
92.	*Carissa congesta* Wt.	Karvand	D., Ec.
93.	*C. inermis* Vahl		Sem.
94.	*Ervatamia heymean* (Wall) Cooke.	Nagalkuda	Sem., Med.
95.	*Holarrhena antidysenterica* (l.) Wall ex G. Don.	Kuda	D., Med.
96.	*Rauwolifia densiflora*	Hadki	MD., Med.
97.	*Tabernaemontana divaricata* (l.) R. Br.	Tagar	C.
	ASCLEPIADACEAE :		
98.	*Hoya wightii* Hook. f.		Sem.
	LOGANIACEAE :		
99.	*Strychnos colubrina* L.		MD.

	Botanical name	Local name	Remarks
	CONVOLVULACEAE :		
100.	*Merremial vitifolia* (Burm. f.) Hall. f.	Navalichaval ..	MD.
	SOLANACEAE :		
101.	*Solanum indicum* L.	.. ..	MD.
	BIGNONIACEAE :		
102.	*Heterophragna quadriloculare* (Roxb.) K. Schum.	Varas	MD.
	ACANTHACEAE :		
103.	*Adhatoda zeylanica* Medik. ..	Adulsa	C.
104.	*Barleria prionitis* L.	Koiati	C.
105.	*Blepharis asperrima* Nees ..	.. ..	MD.
106.	*Dicliptera zeylanica* Nees ..	.. ..	MD.
107.	*Ecobolium viride* (Forsk.) Alston var. laetevirens (C. B. Cl.) Sant.	.. ..	Sem.
108.	*Eranthemum purpurascens* Nees.	.. ..	MD.
109.	*E. roseum* (Vahl) R. Br. ..	.. ..	MD.
110.	*Gymnostachyum glabrum* (Dalz.) T. Anders.	.. ..	Sem.
111.	*Haplanthus neilgherryenis* Wt.	.. ..	MD.
112.	*Hemigraphis latebrosa* var. *latebrosa* (Heyne ex Roth) Nees.	.. ..	MD.
113.	*Lepidagathis fasciculata* (Retz.) Nees.	.. ..	Sem.
114.	*Rungia pectinata* (L) Nees ..	.. ..	MD.
115.	*Staruogyne zeylanica* (Nees) O. Kuntze.	.. ..	MD., R.
	VERBENACAE :		
116.	*Callicarpa tomentosa* (L.) Murr.	Bisur	MD.
117.	*Clerodendrum viscosum* Vent.	Kodi, Bhandire	MD.
118.	*Lantana camara* L. var. aculeata (L) Mold.	Tantani, Ghaneri	
	LAMIACEAE :		
119.	*Ocimum sanctum* L. ..	Tulas	C., Med.
120.	*Pogostemon purpurascens* Dalz.	Pangla	MD.
	POLYGONACEAE :		
121.	*Polygonum chinense* L. ..	.. ..	MD.
	PIPERACEAE :		
122.	*Pipper trachostachyon* (Miq.) DC.	Mir-vel	MD.
	MYRISTICACEAE :		
123.	*Knema attenuata* (Hook. f. and Thoms) Warb.	Ran-Jaiphal ..	Sem.
	LAURACEAE :		
124.	*Cinnamomum uerum* Presl ..	Dalchini, Tamal-patra.	Sem., Ec.

	Botanical name	Local name	Remarks
125.	*Persea* sp.	Gulam, Pulas ..	Ev.
	THYMELAEACEAE :		
126.	*Gnidia glauca* (Fres.) Gilg. ..	Rametha ..	MD.
	ELAEAGNACEAE : ..		
127.	*Elaeagnus conferta* Roxb. ..	Ambosni, Ambgul	MD., Ec.
	EUPHORBIACEAE :		
128.	*Aporusa lindleyna* Baill Bugdi	.. ..	D.
129.	*Bridelia scandens* (Roxb.) Willd.	Chikni	MD.
130.	*Macaranga peltata* (Roxb.) Muell-Arg.	Chandwad ..	MD.
131.	*Mallatus philippensis* (Lamk.) Muell.-Arg.	Kunku, Shendri	MD.
132.	*Sapium insigne* (Royle) Benth. var. malabaricum (W.t.) Hook. f.	Hura	D.
	ULMACEAE :		
133.	*Celtis cinnamomea Lindl.* ex planch.	.. ..	Sem.
	MORACEAE :		
134.	*Artocarpus heterophyllus* Lamk.	Phanas	C., Ec.
135.	*A. incisa* Linn. f.	.. ..	C.
136.	*Ficus amplissima* J.E. Sm. ..	Pyer	D.
137.	*F. racemosa* L.	Umbar	MD.
138.	*F. religiosa* L.	Pimpal	C.
139.	*F. tkahela* Burm f.	Kel	MD.
	GNETACEAE :		
140.	*Gnetumula* Brongn.	Umbli	Sem.
	ORCHIDACEAE :		
141.	*Dendrobium barbatum* Lindl.	.. ..	Med.
	COSTACEAE :		
142.	*Costus speciosus* (Koen.) Sm.	Kosht-Kolajan ..	MD., Med.
	DIOSCOREACEAE :		
143.	*Dioscorea oppositifolia* L. ..	.. ..	MD.
	SMILACACEAE :		
144.	*Smilax zeylanica* L.	Ghotvel	MD., Med.
	ARECACEAE :		
145.	*Caryota urens* L.	.. ..	MD., Med.
	ARACEAE :		
146.	*Pothos Scandens* L.	Kanel	MD.

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2. Flora of Sangli District

Sangli is a small district lying mainly in the basin of the river Krishna and some smaller ones like Yerla, Varna and others. It has eight talukas of which Shirala taluka and to some extent Atpadi are hilly, and the rest are plain. There is thick jungle at Petlond beyond Shirala. Sangli itself is on the bank of the river Krishna. The greater part of the district lies in plains.

There is post-climax vegetation on the river alluvium of Krishna and others. There is intensive cultivation of the strip type as in Egypt on the Nile. It is practised on the rich yearly deposit of alluvium, the so-called " Malies " where maize, vegetables, and jowar are often cultivated.

The more important places for plant collection lie to the west of Sangli at places like Petlond beyond Shirala. Plants of this place were collected by Profs. S. D. Mahajan and P. B. Vaidya and their list is given here. It will be seen that vegetation here is similar to that of Mahabaleshwar, semi-evergreen or even evergreen vegetation occurring in patches. In the rest of the district, there is only thorny scrub.

In Sangli proper many exotic plants have been cultivated in what is now the Municipal Garden. A number of plants, herbs, shrubs and trees grow on Krishna river banks at Sangli, Jaysingpur and Ankali. *Anthocephalus kadamba* is common at Ankali and an uncommon species of *Equisetum*, *Equisetum ramosissimum* grows here. The list of common plants at these places was prepared by prof. Y. G. Kate which is given here.

No authentic flora of the district is published and references to plants of Sangli in Cooke's '*Flora of the Bombay Presidency*' are few. Flora of Koynanagar is unknown.

2.1. *Plants found around Sangli and Jaysingpur* :

Papaverceae :
Argemone mexicana Linn.

Malvaceae :
Sida rhomboidea

Bombacacea
Bombax ceiba Linn.

Oxalidacae
Oxalis corniculata. Linn.

Rutaceae :
Murraya koenigii Linn.

Meliaceae :
Azadirachta indica Linn.

Rhamnacae :
Zizyphus mauritina

Anacardiaceae:
Mangifera indica Linn.

Moringaceae:
Moringa oleifera L.

Fabaceae :
Butea monosperma (Lam) Taub..
Erythina stricta Roxb.
Pongamia pinnata L.

Caesalpiniaceae :
Cassia auriculata Linn.
C. fistula Linn.
C. tora Linn.

Mimosaceae :
Acacia nilotica (Linn) Diels
Parkinsonia aculeata L:
Prosopis juliflora Dc.

Myrtaceae :
Syzygium cumini (L.) Skeels :

Cactaceae
Opuntia dilleniblaw

Apiaceae
Centella asitica L.

Asteraceae :
Blumea oxyodunta Dc.
Parthenium hysterophorus
Tridax procumbens Linn.

Plumbaginaceae :
Plumbago zeylanica

Apocynacene ;
Carissa congesta Wt.
Nerium indicum Mill
Thevetia peruviana Sch.
Cuscuta reflexa Roxb.

Solanaceae :
Solannum indicum Linn.
Withania somniferum Dunal

Acanthaceae :
Adhatoda vesica Nees

Verbenaceae :
Clerodendrum inerme Gaertn
Duranta rapens Linn.
Lantana camara var. *lenleata* Mold.
Vitex neggndo Linn.

Lamiaceae :
Leucas aspera Spr.

Nyctaginaceae :
Boerhaavia diffusa Linn.

Amarantacene :
Achyrnthes aspera Linn.

Euphorpiaceae :
Phyllanthus emblica Linn.
Euphorbia hirta Linn.
E. tirucalli Linn.
Phyllanthus niruri Linn.
Chrozophora prostrata Dllr.

Moraceae :
Ficus racemosa Linn.
F. religiosa Linn.
F. benghalenais

Casuarinaceae :
Casuarina equisetifolia Linn.

Agavaceae :
Agave americana Linn.

Pontederiaceae :
Eichornia crassipes Solm.

Cyperaceae :
Cyperus scariosus R. Br.

Poaceae :
Cynodon dactylon Pers.

2.2. *Flora and Vegetation of Petlond* :

This is a small village about 50 miles west of Islampur. Its altitude is about 920 m above M. S. L. It lies on a ridge surrounded by major off-shoots of Sahyadri ranges. Its highest peak close to Petlond is about

1010 m high. It is a flat tableland. It is full of perennial and temporary streams and has a river. The rocks are of trap origin. The soil is lateritic and gravelly, reddish, brown in colour. It is not very deep, as the soil from the top is generally washed away. The average annual rainfall is 5461 mm. from June to September. July is the rainiest. During monsoons humidity is 90-100 per cent, but otherwise much less. Even then there are no trees because of high rainfall and the top soil being poor. It does not sustain rich vegetation as at Khandala. In the valleys it consists of evergreen as well as moist deciduous species. The evergreen forests are surrounded by patches of mixed vegetation, often dense. Some evergreen pockets represent climatic climax in this area. The trees and shrubs are interminged with lianas, climbers. Epiphytes, ferns, orchids, aroids, mosses, liveworts and Lichens are abundant. Dense evergreen patches do not encourage any undergrowth. Fungi on soil are plentiful. The following are the important dominant plants of this place.

The vegetation here is similar to that at Khandala and that is largely due to similar geographical situation and heavy rainfall.

Vegetation of Vetlond

Ranunculaceae :
Clematis triloba Heyne.
C. gouriana Roxb.
C. wightiana Wall.

Dilleniaceae :
Dillenia pentagyna Roxb.

Menispermaceae :
Cocculus macrocarpus Wight.
Cyclea burmanni Miers (Bl.) Diels

Cruciferae :
Cardamine subumbellata Hook.

Capparidaceae :
Capparis pedunculosa var. *longispina* Hook and Thoms.

Bixaceae :
Flacourtia latifolia T. Cooke.

Guttiferae :
Garcinia xanthochymus Hook.

Ancistrocladaceae :
Ancistrocladus heyneanus Wall.

Malvaceae :
Sida cordifolia Linn.
Hibiscus furcatus Willd.
Bombax malabaricum DC.
=*Salmalia malabarica* (DC.) Schoot and End.

Tiliaceae :
Grewia tiliaefolia Vahl.
G. microcos Linn.
=*Microcos paniculata* Linn.

Linaceae :
Linum mysorens Heyne

Rutaceae :
Glycomis pentaphylla Corr.
Murraya koeningii Spreng.
Luvunga eleutherandra Dalz.
Atalantia racemosa Wight and Arn.

Olacaceae :
Mappia foetida Miers

Celastraceae :
Celastrus paniculata Willd.
Gumnosporia rothiana Laws.
. *Montana* Benth.

Rhamnaceae :
Zizyphus rugosa Lamk.
Scutia indica (Burm.) Kura

Vitaceae :
Leea sambucina Willd.
=*L. Indica* (Burm.) Merr.

Sapindaceae :
Hemigyrosa canescens Thwaites
Allophylus cobbe Blume

Anacardiaceae :
Odina woodier Roxb.
Holigarha grahami Hook.

Leguminosae (Fabaceae) :

Papilionaceae :
Crotolaria verrucosa Linn.
Indigofera pulchella Roxb.
Geissapis cristata Wight
Smithia blanda, var. *racemosa* Baker
S. hirsuta Dalz.
Desmodium laxiflorum DC.
D. triquetrum DC.
Erythrina indica Lamk.
Vigna capensis Walp.
Atylosia lineata Wight
Flemingia strobilifera R. Br.
=*Moghania strobilifera* (Linn) Jacks.
Dalbergia latifolia Roxb.

Caesalpinaceae :
Wagatea spicata Dalz.
Cassia tora L.
Bauhinia malabarica Roxb.

Mimosaceae :
Acacia intsia Willd.
A. pennata Willd.
Albizzia procera Benth.

Rhizophoraceae :
Carallia integerrima DC.
=*C. brachiata* (Lour.) Merr.

Combretaceae :
Terminalia bellerica Roxb.
T. chebula Retz.
T. tomentosa Wight.
Anogeissus latifolia Wall.
Combretum extensum Roxb.

Myrtaceae :
Eugenia hemispherica Wight
Syzygium cumini Linn.
Eugenia heyniana Duthie

Melastomaceae :
Memecylon umbellatum Burm.

Lythraceae :
Ammannia floribunda C. B. Clarke
A. baccifera Linn.
Woodfordia floribunde Salisb.
Lagerstoremia lanceolata Wall.

Umbelliferae :
Pimpinella monoica Dalz.
P. adscendense Dalz.

Rubiaceae :
Anthocephalus indicus A. Rich.
Mitragyna parvifolia Korth.
Wenlandia notoniana Wall.
Randia dumetourm Lamk.
Ixora nigricans Br.
Ixora brachiata Roxb.
Ixora parviflora Vahl.
=*I. arborea* Roxb. ex. Sm.
Pavetta indica Linn.
Rubia cordifolia Linn.

Compositae :
Vernonia cinerea L.
V. indica C. B. Clarke.
Elephantopus scaber Linn.
Conyza stricta Willd.
Blumea membranacea DC.
B. oxyodonta DC.
Sphaeranthus indicus Linn.
Artemisia vulgaris Linn.
Senecio edgeworthii Hook.
S. grahami Hook.
Tricholepis amplexicaulis C. B. Clarke
Flaveria contragerba Pers.

Myrsinaceae :
Maesa indica Wall.
E elia viridiflora Schlett.

Sapotaceae :
Sideroxylon tomentosum Roxb.

Ebenaceae :
Maba nigrescens Dalz.
Diospyros melanoxylon Roxb.

Styraceceae :
Symplocos beddomei C. B. Clarke

Oleaceae :
Jasminum malabaricum Wight
Olea dioica Roxb.

Apocynaceae :
Carissa congesta Linn.
Wrightia tomentosa Roem.

Asclepiadaceae :
Gymnema sylvestris R. Br.
Marsdenia volubilis T. Cooke.
Hoya wightii Hook.

Gentianaceae :
Canscora diffusa R. Br.
Swertia decussata

Boraginaceae :
Cynoglossum denticulatum
var. *zeylania* C. B. Clarke

Convolvulaceae :
Argyreia hookeri C. B. Clarke
A. involucrata C. B. Clarke

Acanthaceae :
Strobilanthes callosus Nees.
S. ixiocephalus Benth.
Haplanthus verticillaris Nees
Lepidagathis cuspidata Nees
Eceobium linneanum Kntz

Verbenaceae :
Lantana indica Roxb.
Callicarpa lanata Linn.
Tectona grandis Linn.
Clerodendron serratum Spreng.
C. infortunatum Linn.
=*C. viscosum* Vent.

Labiatae :
Plectranthus stocksii Hook.
P. incanus Link.
=*P. mollis* (Ait). Spreng.
Pogostemon purpurascens Dalz.
Dysophylla stellata Benth.
Colebrookea oppositifolia Sm.
Anisomeles ovata R. Br.
Leucas ciliata Benth.

Polygonaceae :
Polygonum plebejum R. Br.
P. chinense Linn. var. *ovatifolia* Meissn.

Piperaceae :
Piper nigrum Linn.
P. hookeri Miq.

Lauraceae :
Cinnamomum zeylanicum Blume
Actinodaphne hookeri Meissn.
Litsea zeylanica Nees

Elaeagnaceae :
Elaeagnus latifolia Linn.

Loranthaceae :
Loranthus cuneatus Heyne
=*Taxillus cuneatus* (Roth.) Danser
L. longiflorus Desr.
=*Dendrophte falcata* Linn. (f). Etting.
Viscum articulatum Burm.
=*V. nepalense* Spreng.
V. angulatum.

Euphorbiaceae :
Euphorbia rothiana Spreng.
Bridelia retusa Spreng.
B. hamiltoniana Wall.
Glochidion hohenackeri Bedd.
Phyllanthus reticulatus Poir.
=*Kirganelia reticulata* (Poir) Baill.
Mallotus phillippensis Muell.
Macaranga peltata Roxb.

Urticaceae :
Ficus retusa Linn.
F. arnottiana L.
F. tsiela L.
F. glomerata Roxb.

Salicaceae :
Salix tetrasperma Roxb.

Orchidaceae :
Oberonia recurva Lindl.
Dendrobium microbolbon A. Rich.
D. *barbatulum* Lindl.
Eria dalzelli Lindl.
Aerides maculesum Lindl.
A. crispum Lindl.

Musaceae :
Musa superba Roxb.

Liliaceae :
Smilax macrophylla Roxb.

Palmae :
Phoenix sylvestris L.
Caryota urens L.

Pandanaceae :
Pandanus farcatus Roxb.

Typhaceae :
Typha angustata Bosy.

Cyperaceae :
Cyperus pumilus Linn.
C. compressus L.
C. iria L.
C. nutans Vahl.
Kyllinga triceps Rottb.
Fimbristylis aestivalis Vahl.
F. digitata Boeek.
Carex mercarensis Hochst var. *major* Stei

Gramineae :
Setaria glauca Beauv.
Digitaria sanguinalis Scop.
var. *ciliaris* Prain
D. royleana Prain
Paspalum compactum Roth.
Apluda varia Hook.
Ischaemum laxum Br.
Themeda imberbis T. Cooke
T. triandra Hook.
Iseilema wightii Anders.
Arundinella tenella Nees and Wight
Eragrostis amabilis Wt. and Arn.
Bambusa arundinacea Willd.
Dendrocalamus strictus Nees

3. Flora of Satara District

Satara is a hilly district drained by Krishna, Koyna, Iravati and other rivers flowing through Krishna basin. These rivers rise from Mahabaleshwar which is the second highest peak of Sahyadri, 1438 m. in height. It lies at the west edge of the Sahyadri mountains. It gets about 6226 mm. of rain and has evergreen vegetation on Konkan side and semi-evergreen forests on Desh side. Further east the vegetation consists of dry deciduous forests. Panchgani is another place rich in variety of flora. Though only 20 kilometres east of Mahabaleshwar it gets only 2285 mm. rain. The third important place for flora is Koynanagar, near Helvak standing at the edge of the ghats on west side of the village Helvak, where there is virgin forest. The flora of Koynanagar area and Koyna valley has not been worked out. A check list of plants of Koyna area is given here mainly on the basis of plants collected by Dr. S. D. Patil.

On the other hand, the flora of Mahabaleshwar and Panchgani is fairly well-known. It also needs revision. Dr. Razi has given an account of Panchgani plants after Blatter's in 1908 or Birdwood's (1896) account of Mahabaleshwar plants, there being no systematic account of the flora of both these places. Both the places lie in high hilly region of Sahyadris. Recently, Prof. P. V. Bole has been revising plants of Mahabaleshwar in Bombay Natural History Society's Journal.

Besides these, the plants of Kas area near Satara have been explored by Dr. P. B. Chavan and his associates (1973). Their list and account of the flora of Kas area are given here. In all these areas the ratio of wet to dry season is 3 : 9. Naturally, the vegetation is mostly of the deciduous type—dry or moist. In between at high altitude, there are pockets of evergreen vegetation in deep ravines at high elevation.

Soil erosion is very conspicuous either due to heavy rainfall, temperature or winds. This results in lateritic soils getting washed away, progressively gathering at the lower levels. They get leached and become deficient in calcium, potasium and phosphorus. But in the valleys on Desh side, the forest leaf litter gets mixed with soils and soils become fertile. At places practically all the top soil is washed away and hard basalt is exposed on the westerly hills around Satara, Panchgani etc. The Kas area near Satara has improved in complexion because of the artificial bund constructed there. The following pages give a sketch of the flora of important places in Satara district.

3.1 . *Flora of Kas area near Satara.*

Kas (17 ° 40′ N and 73 ° 56′ E) is near Satara town on a spur of Sahyadri 1310 m. high. The bund here was constructed in 1886. It produced a lake supplying potable water to Satara. The climate of the area is temperate. The rainfall is between 381—457 cm., mostly between June to October.

Soil like the soils at other places in Satara district is red being of lateritic origin. Its PH varies from 6 to 6.5. The area is well protected from winds by surrounding hills but vegetation is much destroyed by biotic factors, especially man and forest fires. Porcupines add to the destruction of vegetation. References to flora of Satara district are found in Hooker (1812—1897), Nairne (1894), Cooke (1908), Vartak (1956), besides stray references in some others. Chavan and others (1973) have described 128 angiosperm species belonging to 116 genera of 54 families, and added later 84 species and 16 more families. The vegetation is either moist deciduous or in parts, mixed or dry deciduous. This becomes apparent from the subjoined list of plants, which can be compared with that of Panchgani.

On the whole, it may be said that the flora of Satara district is much varied and rich. It is typical of the regions adjoining Sahyadris.

Flora of Kas area

(after P. B. Chavan, V. P. Khandekar, S. H. Mahamulk, 1973.)

Ranunculaceae	Habitat
Clematis gouriana Roxb.	Roadside
Menispermaceae :	
Stephania japonica (Thunb) Miers ..	Roadside
Brassicaceae (Cruciferae) :	
Cardmaine trichocarpa Hochst	
Flacourtiaceae :	
Flacourtia indica Merr.	
F. latifolia Cooke	

Polygalaceae :		
Polygala persicariaefolia D. C.	.. ..	On way to Kas
Malvaceae :		
Urena lobata Linn.		
Oxalidaceae :		
Biophyturn sensitivum (Linn.) *D.C.*	..	Open land
Oxalis corniculata Linn.	.. .. ..	Moist places
Balsaminaceae :		
Impatiens balasamina Linn. var *rosea* Hack.		
I. lawii Hack.		
Rutaceae :		
Evodia lunu-ankenda Gaetn.:		
Icacinaceae :		
Nothopodytes foetida Schum.		
Celastraceae :		
Maytenius rothiana		
Rhamnaceae :		
Scutia circumscissa Druce		
Zizyphus rugosa Lamk		
Vitaceae :		
Cayratia elangata		
Sapindaceae :	.. ..	Edges of Forests
Allophylus serratus (Roxb) Radik		
Anacardiaceae :		
Mangifera indica Linn.		
Fabaceae :		
Alysicarpus tetragonolobus Edge.		
Atylosia lineata Wt. and Arn.		
Crotolaria retusa Linn.		
Desmodium rotundifolium Bak.		
Goniogyna hirta (Willdi)Ali		
Indigofera dalzelli Cooke	.. .. ..	On rocks
I. cassioides.		
Moghania nilgherriensis		
M. strobilifera (Linn.) St. Hil. ex. Jacks		
Smithia bigemina Dalz.	.. .. ..	Amongst grasses in rainy season.
Vigna radiata	.. ..	In grasses
V. ratiata var. *sublobata*		
V. vexillata Rich.		
Caesalpiniaceae :		
Cassia fistula Linn.		
Droserceae :		
Drosera indica Linn.	.. .. ..	In grasses near bund.
D. burmannii Vahl.	.. .. ..	By lake side.
Combretaceae :		
Combretum ovalifolium Roxb.		
Terminalia chebula Retz.		

Myrtaceae :
Syzygium cumini (Linn) Skeels

Melastomataceae :
Memecylon umbellatum Burm.

Lythraceae :
Rotala densiflora (Roth) Koehne
Woodfordia fruticosa Salisb .. .. Road to Yawteshwar

Cucurbitaceae :
Dicoelospermum ritchiei C. B. Clarke
Mukia madersparana
Trichosanthes bracteata (Lamk) Voigt

Begoniaceae :
Begonia crenata Dryand

Aizoaceae (Molluginaccae)
Glinus lotoides Linn.

Apiaceae (Umbelliferae)
Centella asiatica (Linn.) Urb
Heracleum concanense Dalz.
Pimpinella sp.

Rubiaceae :
Canthium dicocum var. *umbellatum* Gamble
Meyna laxiflora Robyns
Neanotis foetida (Benth. and Hook. f.) Lewis
Oldenlandia corymbosa Linn.
Hedyotis corymbosa
Oldenlandia sp.
Pavetta crassicaulis Bremk.
Psychotria truncata Wall.
Rubia cordifolia Linn.
Wendlandia thyrsoidea R. and S.
Xeromphis spinosa (Thunb) Keay

Asteraceae :
Artemisia sp.
Blumea laura DC.
Caesulia axillaris Roaxb.
Eclipta prostrata (Linn) L.
Senceio grahami Hook. f.
Sphaeranthus indicus Linn.

Campanulaceae :
Wahlenbergia peduncularis Schrad.

Lobeliaceae :
Lobelia nicotianaefolia Heyne

Plumbaginaceae :
Plumbago zeylanica Linn.

Sapotaceae :
Zantolis tomentosa (Roxb) Ref.

Oleaceae :
Jasminum malabaricum Wight
Olea dioica Roxb.

Apocynaceae :
Carissa congesta Wt.
Rauwolfia serpentina (Linn) Benth ex. Kurz

Asclepiadaceae :
Asclepias curasavica Linn.
Calotropis gigantea (Linn) R. Br.
Ceropegia bulbosa Roxb.
C. oculata var. *oculata* Hook.
Cryptolepis buchanani R. and S.
Dragea volubilis (Linn. f.) Benth. ex. Hook f.
Gymnema sylvestre (Retz.) Schult.
Hemidesmus indicus Schult. .. .. Open land.
Leptadenia reticulata Wt. and Arn.
Pergularia daemia (Forsk.) Blatt.

Gentianaceae :
Canscora diffusa R. Br.
Exacum bicolor Roxb.
E. lawii Clarke
Nymphoides indicum (Linn) O. Kuntze

Boraginaceae :
Adelocaryum coelestinum (Lindl.) Brand
Cordia dichotoma Forst. f.
Trichodesma amplexicaule Roth

Convolvulaceae :
Argyreia cuneata Ker-Gawl.
Evolvulus alsinoides Linn.

Solanaceae :
Solanum indicum Linn.

Scrophulariaceae :
Limnophila indica (Linn) Druce.
Ramphicarpa longiflora (Arn.) Benth.
Striga densiflora Benth.
S. gesmeroides (Willd.) Vatke

Lentibulariaceae :
Utricularia reticulata Sm.
U. striatula Sm.
Utricularia sp.

Thunbergiaceae :
Thunbergia laevis Nees

Acanthaceae :
Adhatoda vasica Nees
Asystasia dalzelliana Sant.
Blepharis asperrima Nees
Carvia callosa (Nees) Bramek.
Eranthemum roseum (Vahl) R. Br.
Haplanthus neilgherryensis Wt.
Hygrophila auriculata (Schum) Heyne
Justicia simplex Linn.
Lepidagathis cristata Willd.
L. cuspidata Nees

Acanthaceae—*cont*.
Peristrophe bicalyculata (Retz.) Nees.
Pleocaulus ritchiei (Clarke) Brem.
Rungia repens (Linn) Nees

Verbenaceae :
Clerodendrum serratum (Linn) Morn.

Labiaceae :
Colebrookia oppositifolia Sm.
Dysophylla stellata Benth.
Lavandula burmanni Benth.
Leucas biflora R. Br.
L. stelligera Wall ex Benth.
Plectranthus stocksii Hill
Pogostemon parviflorus Benth.

Amaranthaceae :
Achyranthes aspera Linn.
Allmania nodiflora R. Br.
Alternanthera sessilis (Linn)

Polygonaceae :
Polygonum chinense Linn. var *ovalifolia* Meissn.
P. glabrum Willd.
P. plebejum R. Br.

Lauraceae :
Actinodaphne angustifolia Nees
Litsea stocksii Hook.

Thymeliaceae :
Lasiosiphon eriocephalus Decne.

Elaeagnaceae :
Elaeagnus conferta Roxb.

Loranthaceae :
Viscum angulatum Heyne

Santalaceae :
Osyris wightiana Wall ex. Wt.

Balanophoraceae :
Balanophora indica Wall. .. .. .. On roots of *Syzygium cumini*.

Euphorbiaceae :
Bridelia retusa (Dennst.) Alston
B. squamosa Greham
Euphorbia antiqorum Linn.
E. acaulis Linn.
E. hitra Linn.
E. rothiana Spreng.
Glochidion hohenackeri Bedd.
Phyllanthus asperulatus Hutch.
P. reticulata Poir Baill.
Securinega leucopyrus (Willd.) M. Arg.
Tragia muelleriana var *unicolor* (M. Arg.) P. and H.

Urticaceae :
Debregeasia longifolia (Burm) Wedd.
Giraldinia zeylanica Decne.
Lecanthus peduncularis (Wall.) Wedd.
Pouzolzia pentandra Benn.

Moraceae :
Artocarpus heterophyllus Lamk.

Salicaceae :
Salix tetrasperma Roxb.

MONOCOTS

Orchidaceae :
Aerides crispum Lindl.
Dendrobium barbatulum Lindl. .. .. On *Xeromphis spinosa*.
D. malebae Gammie
D. mierobulbon Rich.
Habenaria crassifolia A. Rich.
H. gibsoni Hook. f.
H. grandifloriformis Blatt and M. C.
H. heyneana Lindl.
Malaxis versicolor Lindl.
Oberonia recurva Lindl.

Zingiberaceae :
Curcuma pseudomontana Grah.
Zingiber cernuum Dalz.
Z. zerumbet Foscoe.

Hypoxidaceae :
Curculigo orchioides Gaertn.
Hypoxis aurea Lour.

Amaryllidaceae :
Crinum brachynema Herbert.

Dioscoreaceae :
Dioscorea pentaphylla Linn.

Liliaceae :
Asparagus racemosus Willd. var. *javanica* Baker.
Chlorophytum laxum R. Br.
Gloriosa superba Linn. .. .. .. Way to Kas.
Dipcadi montanum Dalz.
Iphigenia indica (Linn) A Gray.
Scilla hyacinthiana (Roth) Mcbride.

Smilacaceae :
Smilax zeylanica Linn.

Commelinaceae :
Commelina diffusa Burm. f.
Cyanotis tuberosa Roxb. Sehult. f.
Murdannia semeteres Sant.
M. versicolor (Dalz.) Bruckn.
M. virgata (Linn) Bruckn.

Pandanaceae :
Pandanus furcatus Roxb.

Araceae :
Arisaema murrayi (Grah.) Hook.
A. neglectum Schott.

Eriocaulaceae :
Eriocaulon sp.

Cyperaceae :
Cyperus liria Linn.
C. malabaricus (Clarke) Cooke
C. triceps (Rottb.) Endl.

Poaceae :
Andropo gon pumilus Roxb.
Arundinella metzii Ho ckst et Mig.
Aristida adscensienis Linn.
Brachiaria reptans Linn.
Chrysopogon montanus Linn.
Cynodon dactylon Linn.
Erqurostis pilosa (Linn.) Beauv.
E. tenuifolia Hock tt. ex Steud.
E. unioloides (Retz) Nees ex. Steud.
Heteropogon contortius (Linn) Beauv.
Jansenella griffithiana (C. Muell) Bor.
Oplismenus compositus (Linn) Beauv.
Paspalidium flavidum (Retz) A. Camus
Paspalum scrobiculatum Linn.
Setaria glauca (Linn.) Beauv.
S. tomentosa (Roxb.) Kunth
Thelepogon elegans Roth
Themeda arundinacea Ridley

3·2. Flora and Vegetation of Panchgani :

Panchgani is a well-known hill station in Satara District. It lies 12.8 km away from Wai and about 20 km from Mahabaleshwar. Its altitude at the Tableland is 4378 feat. The town of Panchgani is at 4300′. It is less than Mahabaleshwar, but the difference between Mahabaleshwar and Panchgani is tremendous. Mahabaleshwar gets 6226.3 mm of rains, but Panchgani gets about 2285 mm of rain as it lies in rain shadow. Its temperature ranges from 56-100 °F. It has generally about 71° F mean temperature at noon. Geologically it stands on volcanic rocks, the Deccan traps. The soil on the top hills is reddish lateritic. But it is not deep. Laterite is of porous argillaceous type. It gets saturated with water in rainy season but hardly retains it due to iron peroxide in it. The various regions of Panchgani are characterised by particular species. *Gravillea robusta* is grown all over except on Tableland, making Panchgani look like an Alpine town.

The most significant feature of Panchgani is tableland. This is reached by a zig-zag path from town. Many Papilionaceous plants like *Smithia hirsuta*, *Eriocaulon* species grow here and there. There are two small lakes which have *Dysophylla stellata* var. *gracilis* and carpets of *Utricularia*. At a little lower altitude *Aneilema*, *Alysicarpus belgaumensis* are common. In the rainy season the tableland is full of monsoon ephemerals e.g. species of *Habenaria*, *Striga*, *Dipcadi montanum* etc., *Isoetes dixitii* is found in the lake on tableland but very often the plants get dried by about October. Below the tableland, several ferns and

shrubs of *Lasiosiphon eriocephalus*, *Pogostemon parviflorus* occur. Ferns like *Nephrolepis*, *Athyrium* are common, besides many other plants.

The flora of Panchgani was worked out by Father Blatter (1908) in a paper published in *Journal of Bombay Natural History Society* [19(2)]: 314-332. He enumerated 367 plants belonging to 89 families and 11 ferns.

After this the plants of this place were restudied by Dr. B. A. Razi (1952). His list contains many new species and grasses which are worthy of note. Since Razi's list is more recent than that of Blatter it is given here. It also includes all Blatter's species besides those added recently.

A remarkable thing of Panchgani plants is that many plants found at Mahabaleshwar are also found here, but they do not form dense vegetation. Even a conifer like *Pinus longifolia* grows here in a private bungalow (*Dil Pazir*) at the foot of the tableland. There are many weeds like *Oenothera rosea*. *Coffea arabica* grows well. They are introduced or are escape from garden. Panchgani is dry for 7 months and humid for 5 months.

Plants of Panchgani (after Razi, 1952)

Ranunculaceae :
Clematis gouriana Roxb.
C. triloba Heyne

Magnoliaceae :
Michelia champaca L.

Anonaceae :
Artabotrys odoratissima R. Br.

Menispermaceae :
Diploclisia glaucescens (Bl.) Diels
Cocculus hirsutus (L.) Diels
=*C. villosus* D. C.
Stephania hernandifolia Walp.
Cyclea burmanni (D. C.) Hook f. and Th.

Papavaraceae :
Argemone mexicana L.

Capparidaceae :
Nasturtium officinale R. Br.
N. subumbellata Hook f.

Pittosporaceae :
Pittosporum floribundum W. and A.

Caryophyllaceae :
Stellaria media Cyril
Saponaria vaccaria L.

Portulacaceae :
Portulaca obraceae L.
=*Talinum cuneifolium* Willd.

Malvaceae :
Abutilon polyandrum W. and A.
Sida acuta Burm.
S. rhombifolia L.

Urena sinuata L.
Kydia calycina Roxb.
Thespesia populnea L.

Tiliaceae :
Grewia microcos L.
G. tiliaefolia Vahl.
Triumfetta pilosa Roth.
T. rhomboidea Jacq.
Erinocarpus nimmoniannus Grah.

Elaeocarpus :
Elaeocarpus oblongus Gaertn.

Linaceae :
Linum mysorense Heyne
Reinwardtia trigyna Planch ex. Hook.

Rutaceae :
Evodia roxburghiana Benth.
Glycosmis pentaphylla Correa
Murraya exotica L.
M. koenigii Spr.
Atalantia manophylla DC.

Burseraceae :
Garuga pinnata Roxb.

Meliaceae :
Soymida febrifuga Juss.
Cedrela toona Roxb.

Malpighiaceae :
Hiptage bengalensis (Linn.) Kurz.
Gymnosporia montana (Roxb.) Benth.

Rhamnaceae :
Scutia indica Brongn.
Zizyphus rugosa Lamk.

Balsaminaceae :
Impatiens acaulis Hook.
I. balsamina Linn. var. *agrestis* Hook f.
I. delzellii Hook f.
I. inconspicua Benth var. *ramosssima* Bl.
I. pulcherrima Dalz.

Sapindaceae :
Allophylus cobbe Bl.

Anacardiaceae :
Mangifera indica L.

Leguminosae :
Sub-family : Mimosoideae
Mimosa pudica L.
Acacia intsia (Linn.) Willd.
Albizzia amara Boivin.
A. lebbek Benth.
A. stipulata Boivin.
Grona dalzelli Baker

Sub-family Caesalpiniodeae :
Wagatea spicata Dalz.
Cassia fistula Linn.
Bauhinia racemosa Lamk.
Sub-family : Papilionaceae
Desmodium triflorum DC.
Vigna capensis Walp.
Atylosia lineata W. and A.
Cylista scariosa Roxb.
Dalbergia lanceolaris Linn
D. latifolia Roxb.
Pongamia glabra Benth.

Rosaceae :
Fragaria vesca L.
Prunus persica Stocks.
Pyrus malus L.
Rosa multiflora Thunb.
Rubus lanciocarpus Sm.

Crassulaceae :
Bryophyllum pinnatum (Limk.) Kurz
(=*B. calycinum* Salisb.)
Kolanchee spathulata DC.

Combretaceae :
Anogeisus latifolia Wall.
Calycopteris floribunda Lamk.
Eugenia jambolana Lam.
(=*Eugenia heyneana* Duthie)

Melastomaceae :
Memecylon umbellatum Burm.

Lythraceae :
Ammannia floribunda Clarke
A. pentandra Roxb.
Lagerstroemia indica L.
L. parviflora Roxb.

Cucurbitaceae :
Trichosanthes palmata Roxb.
Cucumis melo L.
Melothria heterophylla Cogn.
M. leiosperma Cogn.
M. maderaspatana Cogn.
M. perpusilla Cogn.

Begoniaceae :
Begonia crenata Dryand.

Umbelliferae :
Carum stictocarpum Clarke
Pimpinella adscendens Dalz.
P. candollena W. and A.
P. monoica Dalz.
P. tomentosa Dalz.
Heracleum concanicum Dalz.

Rubiaceae :
Mitragyna parvifolia Korth.
Wendlandia notoniana Wall.

Odlenlandia corymbosa L.
Anotis lancifolia Hook f.
Pletronia wightii Cooke
Meynia laxiflora Robyns
Xeromphi, spinosa
(=*Vangueria spinosa* Auct.)
Ixora nigricans Br.
I. parviflora Vahl.
Pavetta indica L.
Coffea arabica L.
Hamiltonia suaveolens Roxb.
Rubia cordifolia L.

Campanulaceae :
Cephalostigma schimperi Hochst
Lobelia trigona Roxb.

Compositae :
Centratherum phyllolaenum (DC) Benth.
C. tenue Clarke
Adenoon indicum Dalz.
Vernonia indica Clarke
Adenostemma viscosum Forst.
Dichrocephala latifolia DC.
Conyza stricta Willd.
Bidens biternata Merr. Sherff
(=*B. pilosa* Auct.)
Tridax procumbens L.
Artemisia parviflora Bach-Ham.
A. vulgaris L.
Gynura angulosa DC.
Notonia grandiflora DC.
Senecio edgeworthii Hook f.
Tricholepis glaberrima DC.
Lactuca runcinata DC.

Plumbaginaceae :
Plumbago zeylanica L.

Myrsinaceae :
Maesa indica Well.
Embelia ribes Burm.

Sapotaceae :
Mimusops elengi L.
Symplocos beddomei Clarke

Ebenaceae :
Diospyros melanoxylon Roxb.

Oleaceae :
Jasminum malbaricum Wt.
Ligustrum neilgherrense Wt. Var. *Obovatum* Clarke.

Apocynaceae :
Carissa congesta Wt. (=*C. carandas* L.)
Holorrhena antidysenterica Wall.

Asclepiadaceae :
Calotropis gigantea R. Br.
C. hirsuta W. and A.

Gymnema sylvestre R. Br.
Marsdenia volubilis T. Cooke
Hoya retusa Dalz.
Ceropegia hispida Blatter and McCann

Gentianaceae :
Exacum lawii Clarke
C. diffusa R. Br.
Swertia minor Cooke
Limnanthemum cristatum Griseb.
L. indicum Thw.

Boraginaceae :
Cynoglossum denticulatum A. DC. Var. *zeylanicum* Clarke
Paracaryum coelestinum Benth.
P. malabaricum Clarke

Convolvulaceae :
Argyreia hookeri Clarke

Solanaceae :
Solanum giganteum Jacq.
S. indicum L.
Physalis peruviana L.

Scrophulariaceae :
Verbascum coromandelianum (Vahl.) Kuntze.
(=*Celsia coromandeliana* Vahl.)
Kickxia ramosissima (Wall.) Janchen.
(=*Linaria ramosissima* Wall.)
Bonnaya veronicaefolia Spreng.
Striga gesneroides (Willd.) Vatke.
(=*S. orobanchoides* Benth.)
Sopubia delphinifolia (Roxb.) G. Don.

Lentibulariaceae :
Utricularia caerulea L.
U. striatula Sm.

Acanthaceae :
Asteracantha longifolia (Linn.) Nees
Strobilanthes callosus Nees
S. heyneanus Nees
S. ixiocephalus Benth.
S. scrobiculatus Dalz.
Haplanthus verticillaris (Roxb.) Nees
Barleria strigosa Willd. Var. *terminalis* Clarke
Lepidagathis cuspidata (Wall.) Nees
Rungia elegans Dalz. & Gibs.
Rungia pectinata (L.) Nees (=*R. parviflora* Nees var. *pectinata* Clarke)
Dicliptera zeylanica Nees
Justicia betonica Linn. var. *ramosissima* Clarke
J. micranth Heyne
J. trinervia Vahl.
Adhatoda vasica Nees
Rhinacanthus communis Nees

Verbenaceae :
Lantana camara Linn. var. *aculeata* Moldenke
Callicarpa lanata L.
Clerodendrum serrulatum Spreng.

Labiatae :
Plectranthus mollis (Ait) Spr. (=*P. incanus* Link. *P. stocksii* Hook f.)
Lavandula perrottetii Benth (=*L. gibsoni* Grah.)
Pogostemon parviflorus Benth.
Dysophylla stellata Benth.
Colebrookea oppositifolia Sm.
Micromeria capitata Benth.
Anisomeles heyneana Benth.
Leucas ciliata Benth.
Nepeta hindustana (Roth) Haines
(=*N. ruderalis* Buch-Ham.)
N. hindustana (Roth) Haines var. *woodrowii*
Salvia plebeja R. Br.

Nyctaginaceae :
Boerhaavia diffusa L. (—*B. repens* L).

Amarantaceae :
Celosia argentea L.
Achyranthes aspera L.
Aerua lanata Juss.
Alternanthera sessilis (L.) R. Br.

Chenopodiaceae :
Chenopodium ambrosioides L.

Polygonoceae :
Polygonum elatum Buch. Ham.
P. chinense L. *var. ovalifolium* Meissn.
P. glabrum Willd.
P. plebejum R. Br.

Piperaceae :
Piper hookeri Miq.

Lauraceae :
Litsea stocksii Hook f.
L. tomentosa Heyne
Actinodaphne hookeri Meissn.

Euphorbiaceae :
Euphorbia acaulis Roxb.
E. hirta L. (=*E. pilulifera* L.)
Bridelia retusa Spr.
Emblica officinalis Gaertn (=*Phyllanthus emblica* L.)
Fluggea leucopyrus Willd.
Glochidion hohenackeri Bedd.
Chrozophora rottleri Klotzsch.
Acalypha brachystachya Hornem.

Thymelaeaceae :
Lasiosiphon eriocephalus Decne.

Eleagnaceae :
Elaeagnus conferta Roxb. (=*E. latifolia* L.)

Loranthaceae :
Loranthus scurrula L.
Viscum angulatum Heyne ex DC.

Urticaceae :
Girardinia zeylanica Decne.
Lecanthus peduncultris (Wall) Wedd.
(=*L. wallichii* Wedd.)

Moraceae :
Ficus bengalensis L.
F. carica L.
F. infectoria Roxb.
F. religiosa L.
F. retusa L.
F. tomentosa Roxb.
Morus alba L.

Salicaceae :
Salix tetrasperma Roxb.

Centrophyllaceae :
Centrophyllum demersum L.

Orchidaceae :
Dendrobium barbatulum Lindl.
D. mabelae Gammie.
Porpax lichenora Cooke.
Eria dalzellii Lindl.
E. rupestris Blatter and McCann.
Aerides maculosum Lindl.
Microstylis versicolor Lindl.
Eulophia pratensis Lindl.
Peristylus xanthochlorus Blatter and McCann.
Habenaria cerea Blatter and McCann.
H. cerea Blatter and McCann Var. *Polyantha* Blatter and McCann.
H. crassifolia A. Rich.
H. digitata Lindl.
H. grandifloriformis Blatter and McCann.
H. grandifloriformis Blatter and McCann Var. *acquloba* Blatter and McCann.
H. heyneana Lindl.
H. rariflora A. Rich.
H. rariflora A. Rich var. *latifolia* Blatter McCann.
H. suaveolens Dalz.
H. variabilis Blatter and McCann.

Musaceae :
Ensete superbum (Roxb.) Cheeseman.
(=*Musa superba* Roxb.)

Zingiberaceae :
Hedychium coronarium Koenig.
Hitchenia caulina Baker.

Amaryllidaceae :
Crinum latifolium L.
Curculigo orchioides Gaertn.

Liliaceae :
Asparagus racemosus L. var. *javanica* Baker.
Smilax macrophylla Roxb.
Chlrophytum orchidastrum Lindl.

Commelinaceae :
Commelina nudiflora L.
Aneilema sinicum Lindl.
A. spiratum R. Br.
Cyanotis axillaris Schult. f.

C. cristata Schult. f.
C. fasciculata Schult. f.
C. fasciculata Schult. Var. f. *glabrescens* Clarke.

Palmae :
Caryota urens L.

Araceae :
Acorus calamus L.
Typhonium amboinense (Rumph) Blatter and McCann (=*Arisarum amboinense* Runpn.)
Ariopsis peltata Nimmo.
Remusatia vivipara Schott.
Arisaema langecaudatum Blatter.
A. murrayi (Grah.) Hook.
Sauromatum guttatum (Wall.) Schott.

Cyperaceae :
Kyllinga brevifolia Rottb.
K. melanosperma Nees.
K. triceps Rottb.
Pycreus capillairs Nees.
P. latespicatus Clarke.
P. nitens Nees.
P. pumilus Bom.
P. sanguinolentus Nees.
Juncellus laevigetus Clarke.
Cyperus aristatus Rottb.
C. digitatus Roxb.
C. eleusinoides Kunth.
C. iria L.
C. macraei Clarke.
C. nutans Vahl.
C. rotundus Linn.
Miniscus paniceus Vahl.
Eleocharis fistulosa Link.
Fimbristylis annua Rsem.
F. dichotoma Vahl.
F. diphylla Vahl.
F. ferruginea Vahl.

Potamogetonaceae :
Potamogeton indicus Roxb.

Graminae :
Dimera ornithopoda Trin.
Ischaemum aristatum Linn.
I. impressum Hack.
I. laxum R. Br.
I. pilosum Hack.
Schima nervosum Stapf.
Apluda aristata Linn.
Peltophorus divergens (Hack.) Camus.
Eulalia argentea Brongn.
Arthraxon echinatus Hochst.
A. hispidus (Thunb.) Mamino.
A. inermis Hook. f.
A. meeboldii, Stapf.
A. quartinianus Nasb.

A. serrulatus Hochst.
Capillipedium hugelli (Hack.} Camus.
Amphilopis pertusa Stapf.
Vetiveria zizanioides (Linn.) Nash.
(=*A. squarrosus* Hook. f.)
=*A. muricatus* Retz.)
Dichanthium annlatum Stapf.
(=*Andropogon annulatus* Forssk.)
D. mccannii Blatter.
D. panchganiense Blatter and McCann.
D. serrafalcoides Blatter and McCann.
Themeda cymbaria Hack.
(=*Anthistiria cymbaria* Roxb.)
T. quadrivalvis O. Ktze.
(=*Anthistiria ciliata* Linn. f.)
T. triandra Forssk.
Iseilema anthephoroides Hack.
I. laxum Hack.
I. prostratum Anders.
(=*I. wightii* Anders).
Eremopogon foveolatus Stapf.
(=*Andropogon foveolatus* Del.)
Andropogon pumilus Roxb.
Cymbopogon citratus Stapf.
(=*Andropogon schoenanthus* (Linn).
C. martinii Stapf.
Hackelochola granularis O. Ktze.
(=*Manisuris gronularis* L.)
Ophiuros exaltatus O. Ktze.
Manisuris forficulata Fischer
(=*Rottboellia divergesns* Hack.)
Pseudanthistiria hispida Hook. f.
Digitaria marginata Link var. *fimbriata* Stapf.
D. longifolia Pers.
Alloteropsis cimicina Stapf.
Brachiaria isachne Stapf.
Paspalum compactum Roth.
P. scrobiculatum L.
Echinochia colona Link.
Oryza sativa L.
Triticum vulgare L.
Bambusa arundinacea Retz.
(=*B. arundo* Klein)
B. valgaris Schard.
Echinochloa stagnina Beauv.
Oplismenus burmanni P. Breauv.
C. compositus Beauv.
Panicum miliaceum L.
Setaria intermedia R. and S.
S. italica Beauv.
S. pallidifusca Stapf. ex. Hubb.
S. plicata T. Cooke.
P. typhoides Stapf of Hubb.
Isachne australis R. Br.
I. elgans Dalz.
I. lisboae Hook. f.
I. miliacea Roth.
Arundinella hispida Ktze.

A. spicata Dalz.
A. tenella Nees.
A. tuberculata Munro.
Garnotia stricta Brongn.
Aristida adscencionis Linn.
(=*A. depressa* Retz.)
A. funiculata Trin. and Rupr.
A. redacta Stapf.
Sporobolus diander Beauv.
S. piliferus Kunth.
S. gangeticus Steud.
Eragrostis nutans (Retz) Nees.
E. tenuiflora Hochst.
E. unioloides Nees.
Cynodon dactylon Pers.
Chloris barbata Swartz.
Eleusine coracana Gaertn.

3·3. Mahabaleshwar Ghats and their flora :

The road goes from Wai to Mahabaleshwar along the edge of the Sahyadri ranges in a tortuous way. On the other side, it goes down *via* Pratapgad to Mahad by the very steep Fitzgerald ghat. The trees seen at high level are : *Glycosmis mauritiana, Memecylon talbotianum, Symplocos beddomei, Ficus rumphii, Alseodaphane semeccarpifolia, Litsea stocksii, Actinonodaphe angustifolia, Artocarpus heterophyllus.*

Shrubs are *Ligustrum perottetii, Rauwolfia densiflora, Scutia circumscissa, Wagatea spicata, Embellia ribes, Pavetta crassicaulis.*

Herbs are *Cardamine trichocarpa, Impatiens acaulis, Arisaema caudatum, Dichanthium panchananiense, Arthraxon raizadae, Smithia agharkarii, Blumea malcolmii, Dysophylla, salicifolia, Rotala floribunda, Arundinella spicata, Swertia densifolia, Hitchenia caulina.*

At the foot of all these ghats on the Konkan side there is thick vegetation and sacred groves or "Dev Raies". From the main ranges of Sahyadris, several lateral spurs run towards Konkan, some extending right upto sea, e.g., those at the end of the ghats like Kankavali, Kudal, Malvan, Sawantwadi, Ugewa Devi, Phonda and Amboli. Various views are held about ghat flora by different authors like Hooker, Cooke, Mani and others. We hold the view that they present vertical sections of the whole vegetation of Sahyadris at different levels and are adapted to various heights in the nitches in ghats, suitable to them. There is also monsoon flora of plants such as *Arissaema, Chlorophytum,* and some other tuberous plants on the upland flats at different levels.

Rainfall at Mahabaleshwar :

About 80—85 per cent of annual rains are received from south-west monsoon. July is the rainiest month. The number of rainy days are 120—125 and mean humidity is always above 60 per cent. The following trees are found in Mahabaleshwar :—

Garcinia talbotii, Mammea surirega, Atalania racemosa, Aglaia elaeagniide, Dysoxylum binecteriferum, Nothopodytes foetida, Syzygium caryophyllatum, Persea macrantha, Homalium zylanicum, Xantolis tomentosa, Mapa nigrescens, Symolocas. courina, Diosoyros candolleana, D. melanoxylon, Beilschmiedia dalzellii, Celtis cinnamomea, Holigarna arnottiana, Hydnocarpus laurifolia, Calophyllum apetalum, Litesea deccanenis.

Shrubs are *Decaschistria trilobata*, *Grewia ritchiei*, *Microcos paniculata*, *Murraya paniculata*, *Ochna squarrosa*, *Scutia circumscissa*, *Lepisanthes tetraphylla*, *Connarus wightii*, *Tuyrraea villosa*, *Syzygium phillyraeoides*, *Canthium dicoccum*, *Rauwofia densiflora*, *Salacia chinensis*.

Herbs are *Cardamine trichocarpa*, *Impatiens acaulis*, *Adenostemma viscosum*, *Nilgirianthus lupillinus*, *Leucas ciliata*.

At the base of the ghat, in the rainy season there is marshy ground which when dried is suitable for rice cultivation. The important trees at the top of the ghat are : *Hydnocarpus laurifolia*, *Diospyros oocarpa*, *Terminalia crenulata*, *T. bellerica*, *Memecylon umbellatum*, on the ghat top shrubs of *Ixora brachiata* and herbs like *Tephrosia tinctoria*, *Clerodendrum viscosum*, *Habenaria marginata*, *Costus specious*, *Gloriosa superba* grow generally mixed with tall woody climbers like *Entade*, *Acacia pennata*, *Anodendron paniculataum*, *Tylophora indica*, *Lygodium flexuorum*. We can see Dev Raies at Amboli. These Dev Raies are peculiar conservatories of trees and they invariably contain some trees or shrubs which are not found in the vicinity.

Important Mahabaleshwar Plants :

A comprehensive list of Mahabaleshwar plants is given by Birdwood (1897). The more common plants of the plateau are given below. They have also been mentioned by Santapau (1952) in his paper on the vegetation of the place. A list prepared from it is given here. Vegetation is evergreen or some semi-evergreen in valleys and pockets. They are very rich in species.

Important common plants on Mahabaleshwar Plateau :

Name of the species :

Ranunculaceae :
Clematis triloba Heyne ex Roth.

Cruciferae :
Capsella burspa-storis Medk.

Capparidaceae :
Capparis spinosa var. *V. vulgaris* Linn.

Pittosporaceae :
Pittosporum floribundum W. & A.

Polygalaceae :
Polygala perisicariaefolia DC.

Caryophylacae :
Saponaria vaccaria Linn.
Stellaria media Linn.
Polycarpon-loeflingiae Benth. & Hook. f.

Sterculiaceae :
Helicteres isora Linn.

Tiliaceae :
Elaeocarpus ablongus Goertn.

Linaceae :
Reinwartlia trigyna Hook.

Geraniaceae :
Impatiens acaulis Hook.

Rutaceae :
Toddalia aculeata Pres.
Murraya exotica Linn. var. *paniculata* Jacq.

Burseraceae :
Boswellia serrata Roxb.

Meliaceae :
Cipadessa fruticosa Blume.

Olaceae :
Mappia foetida Miers.
M. oblonga Miers.

Celastraceae :
Gymnosporia emarginata Roth.

Sapindaceae :
Allophyllus cobbe Blume.

Leguminosae :
Dumasia villosa DC.
Atylosia lineata W. A.
Pongamia glabra Vent.

Rosaceae :
Rubus lasiocarpus Smith.

Crassulaceae :
Bryophyllum calycinum Salisb.

Halorangeaceae :
Myriophyllum intermedium DC.

Melastromaceae :
Ammania floribunda Clarke
A. bacciifera Linn.

Onagraceae :
Genothera rosea.

Cucurbiaceae :
Zonaria sp.

Umbelliferae :
Pimpinella tomentosa Dalz.

Rubiaceae :
Anthosephalus cadamba Miq.
Oldenlandia corymbosa Linn.
Anotis lancifolia Dalz.

Campanulaceae :
Lobelia trialata Buch. Ham.

Plumbagineae :
Plumbago zeylanica Linn.

Asclepiadiaceae :
Ceropegia lawii Hook, f.

Gentianaceae :
Exacum lawii Clarke.
Canscora diffusa R. Br.

Boraginaceae :
Paracaryum caelestinum Benth.

Convolvulaceac :
Porana malabarica Clarke.

Scrophulariaceae :
Ilysanthes hyssopioides Benth.

Verbenaceae :
Clerodendron serrutum Spreng.

Labiatae :
Coleus parviflorus Benth.
Leucas stelligera Wall.

Polygonaceae :
Polygonum pedunculare Wall.

Lauraceae :
Litsaea polyantha Juss.
L. wightiana Wall.

Loranthaceae :
Viscum ramosissimum Wall.

Balanophovaceae :
Balanophora indica Wall.

Euphorbiaccae :
Euphorbia fusiformis Ham.

Urticaceae :
Ficus palmata Fors.

Cupuliferaceae :
Quercus robur Linn.

Hydrocharitaceae :
Blyxa echinosperma Hook. f.

Orchidaceae :
Dendrobium pierardi Roxb.
Phaius albus Lindl.
Habenaria grandiflora Lindl..
H. crassifolia A. rich.

Scitamineae :
Hedychium coronarium var. *flavum* Roxb.

Haemodoraceae :
Ophiopogon intermedius Don.

Amaryllidaccae :
Crinum brachynema.
Agave vivipara Linn.

Commelinaceae :
Aneilema spiratum R. Br.
A. sinicum Lindl.

Aroidae :
Arisaema murrayi Hook.

Cyperaceae :
Pysreus capillaris Nees.

Filiceneae :

Polypodiaceae :
Asplenium lunulatum var. *trapeziforme* Roxb.
Anisogonium esculentum.
Aspidium polymorphum Wall.

Forest Constituents

Recently Santapau (1960) has given in Proc. Sum. Sch. Bot. Darjeeling, 1960 : (30-60) the following plants which occur mostly in deforested areas at Mahabaleshwar :—

Pteridium aquilinum Kuhn
Crotolaria retusa Linn.
Lasiosiphon eriocephalus Decne.
Randia brandisii Gamble.
Memecylon umbellatum Burm.
Syzygium cumini (*L.*) Skeels.
Olea dioica Roxb.
Actinodaphne angustifolia Nees.
Hitchenia caulina Bak.
Cryptocoryne tortuosa Blatt. McC.
Paracaryum malabaricum Clarke
P. lambertianum Clke.
Ligustrum neilgherrense var. *obovat* Clke.
Strobilanthes spp.
Solanum giganteum Jacq.
Glochidion hohenackeri Bedd.
Ficus glomerata Roxb.
Pygeum gardneri Hook. f.
Nothapodytes foetida Sleum.
Canthium dicoccum Merr.
Terminalia chebula Retz.
Osyris wightiana Wall.
Callicarpa tomentosa Murr.
Pavetta indica Linn.
Colebrookea oppositifolia Smith.
Pogostemon plectranthoides Desf.
Carvia callosa Bremek.
Psychotria truncata Wall.
Embelia tsiariam cottam DC.
Thejepaepale ixiocephala Bremek.
Elaeagnus conferta Roxb.
Scutia circumcissa Radlk.
Jasminum malbaricum Wt.
Embelia viridifloria Comm.
Piper hookeri Miq.
Smilax zeylanica Linn.
Capparis longispina Hook. f. and Th.
Oplismenus sp.
Lepidagathis cuspidata Nees.

Monsoon Flora :

Lecanthus pediuncularis
Dichrocephala sp.
I. pulcherrima
I. acaulis
Begonia crenata
Asystasia dalzelliana
Hitchenia caulina Bak.
Zingiber macrostachyum
Eriocaulon spp.
Utricularia spp.
Anotis lancifolia Wall.
A. foetida Benth and Hook f.
Ammannia sp.
Heracleum concanense
Paracaryum malabaricum
Rotala floribunda
Sonerila scapigera
Exacum pumilum Griseb.
E. bicolor Roxb.
Uticularia striatula
Senecio grahamii
Canscora diffusa
Smithia setulosa
Dicoelospermum ritchiei
Mucuna monosperma
Habenaria heyneana Lindl.
H. grandiflora Lindl.
H. panchganiensis Sant and Kapad.
Remusatia vivipara Schott.
Plectranthus stocksii Hook. f.
Begonia crenata Dryand
Impatiens dalzellii Hook. f. and Th.
I. balsamina Linn.
Utricularia caerulea Linn.
U. affinis Wt.
Hypoxis aurea Linn.
Scilla hyacinthina Macbr.
Anagallis pumila Swartz
Lindernia sessiliflora Wettst.
Linum mysorense Heyne
Polygonum nepalense Meisn.
P. chinense Linn.
Pimpinella monoica Dalz.
Heracleum concanense Dalz.
Lecanthus peduncularis Wedd.
Cyanotis cristata Shult.
Asystasia dalzelliana Sant.
Curculigo orchioides Gaertn.
Zingiber macrostachyum Dalz.
Commelina hirsuta Ham.
Arisaema longecaddatum Blatt.

Dry Season Herbs :

Conyza stricta Wall.
Rungia pectinata Nees
Leucas stelligera Wall.

Biological Spectra of Matheran and Mahabaleshwar Flora

A different approach to the study of the Flora of Mahabaleshwar has been made by Dr. F. R. Bharucha and Miss D. B. Pareira (1941) *J. I. B. S.* 20 (4) : 195-211. They studied the flora of these two hill stations on the basis of Raunkier's Life Forms. It is a statistical study of the flora and factors operating. This was possible only because both these places have limited boundaries and because the climatic data is fully known and complete. After analysing the data for both these places, climatic and topographic co-relation was sought with the Biological spectra of other tropical lands. They have concluded that both these places show decidedly phanerophytic plant climate with 52 % and 48 % phanerophytes, respectively. A list of references to their flora is given below in the hope that it will help preparing a complete flora of Mahabaleshwar.

Recently Prof. P. V. Bole started publishing papers in J. B. N. H. S. on the flora of Mahabaleshwar with many additions. They may be consulted.

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3.4. Plants of Koynanagar :

Like Mahabaleshwar there is rich flora at Koynanagar.

Koynanagar is a new township in the hilly region of Satara district, 20.8 km. from Patan. It is approached by a road from Patan going to Chiplun through a short steep ghat of Kumbharli.

Koyna is a tributary of Krishna. It rises with four other rivers (three of which are tributaries of river Krishna) from Kshetra Mahabaleshwar and flows southwards in the valley below Pratapgad till it reaches Helvak. Here it turns eastwards and proceeds towards Karad where it meets Krishna.

Koynanagar has become very famous of late on account of two things, (1) The High Level Hydro-electric Project generating electricity and supplying it to Bombay and several places in Maharashtra; (2) Recent severe earthquake in the area which affected nearly 100 villages and some towns in the neighbourhood. The earthquake came as a rude shock to scientists, especially to geologists who used to believe that Deccan plateau is the most stable part of Peninsular India. Some experts held that impounding of such vast mass of water at such a high level has caused earthquake, while others said that it is due to tectonics, the deep rock strata being unstabled. Still others held that impounding of vast mass of water has not caused the earthquake but it only triggered off the earth tremors as the substrata here have not been stabilised.

Due to creation of the vast lake, several areas have been submerged. There is perpetual humidity here. Many plants must have disappeared and new ones have come. In course of time the flora here is bound to change. Opposite Helvak on the west bank of the river Koyna, there is a virgin forest in the vicinity. This and several other areas have not yet been explored.

The tail water of Koyna dam at Pophli goes through a tunnel (a drop of 1600-2000') straight to turbines in the underground power house. Afterwards the water goes in Vasishthi river going to Chiplun. Dr. G. V. Joshi found that this has changed the composition of trees on this river banks and has altered the factors affecting the mangrove plant community on the Vasishthi river. There is no information whatsoever of the plants and forest communities here, and therefore, the following checklist of plants in the vicinity of Koynanagar as prepared by Dr. S. D. Patil of Poona University is given in the hope that it will encourage further exploration of this place. Besides, these plants, some plants from North Kanara and Goa flora are also found here. This is not to be wondered as the rainfall here is 5000 mm or more, and the place is isolated. It is adjacent to them and is a part of the same botanical province as Malabar. The following lists give important plants at Koynanagar and surroundings.

It will be seen that they are a strange mixture of dry parts of Sahyadri both in Konkan and Desh. The most remarkable elements are those that are common to Koynanagar, North Kanara and Goa.

Plants of Koynanagar area

Ranunculaceae :

Clematis gouriana Roxb.
C. triloba Heyne
C. hedysarifolia DC
C. wightiana Wall.

Menispermaceae :
Cyclea burmanni Miers

Papaveraceae :
Argemone mexicana L.

Polygalaceae :
Polygala erioptera DC.
P. persicariaefolia DC.

Elatinaceae :
Bergia capensis Linn.

Guttiferae :
Ochrocapos longifolius Benth.
Mesua ferbea Linn.
Thymelaceae Lasiosiphon eriosophalus

Portulacaeae :
Portulaca oleracea L.

Malaceae :
Urena lobata Linn.
U. sinuata L.
Kydia calycina Roxb.
Thespesia papulnea L.

Elaeocarpaceae :
Elaecocarpus oblongus Gqaertn

Linaceae :
Linum mysorense Heyne

Rutaceae :
Murraya koenigii

Balsaminaceae :
Impatiens acaulis Hook.

Icacinaceae :
Mappia foetida Miers

Rhamnaceae :
Columbrina rathina Laws.
Scutia indica Brongn.
Zizyphus jujuba Lamk.
Z. oenoplea Mill
Z. rugosa Willd.
Z. xylocarpa willd.

Vitaceae :
Vitis elongata Wall.
V. lanceolata L.
V. woodrowii (Stapf) Santapau
Leea sambucina Willd.
L. macrophylla Roxb.

Anacardiaceae :
Mangifera indica L.

eguminosae : sub fam. Mimosae :
Acacia concinna DC.
A. intsia Willd. add.

Sapindaceae :
Allophylus cabbe Bl.

Combretaceae :
Calycopteris floribunda Lamk.
Terminalia chebula Retz
T. paniculata Roth
T. tomentosa W. and A.

Myrtaceae :
Syzygium cumini (Linn) Skeele
Eugenia heyneana Duthie

Lythraceae :
Ammania beccifera Linn
A. floribunda Clarke
Woodfordia fruticosa Salisl
Lagestroemia lanceolata Wall
Lawsonia inermis L.

Aizoaceae :
Mallugo hirta Thumb.
M. pentaphyllya L.

Umbelliferae :
Carum stictocarpum Clarke
Pimpinella adscendens Dalz.
Heracleum concanicum Dalz.

Rubiaceae :
Wendlandia notoniana Wall.
Pavetta indica L.
Rubia cordifolia L.

Compositae :
Vernonia cinerea (Linn.) Lesg.
Adenostemma viscosum Forest
Ageratum conyziodes L.
Gnaphalium indicum Linn.
Vicoa indica (Willd.) DC.

Myrsinaceae :
Maesa indica Wall.

Styraceae :
Symplocos beddomei Clarke

Oleaceae :
Jasminum malabaricum Wt.
Ligustrum neilgherrense St. var. *obovatum* Clarke

Apocynaceae :
Carissa congesta Wt.
Halarrhena antidysenterica Wall.
Wrightia tomentosa R. and S.

Asclepiadaceae :
Calotropis gigantea R. Br.
Asclepias curasavica Linn.

Gentianaceae :
Exacum lawii Clarke
E. pumilum Gris.

Boraginaceae :
Cynogolossum denticulatum C
C. malabaricum Clarke

Convolvulaceae :
Lettsomia elliptica Wt.
Merremia emarginata Hall. f.

Solanaceae :
Solanum giganteum Jacq.

Scrophulariaceae :
Verbascum coromandelianum (Vahl) Kuntze
Bonnaya veronicaefolia Spreng.
Veronica anagallis Linn.
Striga euphratisoides Benth.
S. gesneroides (Willd) Vatke
Sopubia delphinifolia G. Don.

Acanthaceae :
Asteracantha longifolia (Linn.) Ness
Hygrophila serphyllum T. Anders
Hemigraphis latebrosa Nees var *heyneana*
Eranthemum roseum (Vahl) R. Br.
Strobilanthes collosus Nees
S. heyneanus Nees
S. ixiocephalus Benth.
S. scrobiculatus Dalz.
Lepidagathis cuspidata (Wall.) Nees
Rungta parviflora Nees

Verbenaceae :
Lantana camera Linn. var. *aculeata* Moldenke
Callicarpa lanata L.
Tectona grandis Linn. f.
Clerodendrum serratum (Linn) Murr.
Vitex negundo L.

Labiatae :
Plectranthus costata Buch Ham.
P. mollis (Ait.) Spr.
Pogostemon parviflorus Benth.
Dysophylla stellata Benth.
Colebrookia oppositifolia Sm.
Anisomeles heyneana Benth.
Nepeta hindustana (Roth) var *woodrowii*
Salvia plebeja R. Br.

Amaranthaceae :
Amaranthus spinosus L.
Achyranthes aspera L.

Chenopodiaceae :
Chenopodium ambrosioides Linn.

Polygonaceae :
Polygonum chinense L. var *ovalifolium* Meissn.
P. glabrum Willd.
P. plebejum R. Br. var. *indica* Hook f.
P. serrulatum Cooke

Lauraceae :
Litsea stocksii Hook. f.
Actinodaphne hookeri Meissn.

Proteaceae :
Grevillea robusta Cunn

Santalaceae :
Osyris arborea Wall.

Loranathaceae :
Loranthus longiflorus Desf.
Viscum angulatum Heyne ex DC.
V. articulatum Burm.

Euphorbiaceae :
Euphorbia acaulis Roxb.
E. elegans Spreng.
E. hypericifolia L.
E. rothiana Spr.
Bridelia retusa Spr.
B. squamosa Gehrm.
Acalypha brachystachya Hornem
Homonoia riparia Lour
Tragia involucrata Linn.

Urticaceae :
Gerardinia zeylanica Decne.
Lecanthus peduncularis (Wall).
Pouzolzia bennetteana Wt.
Debregaesia velutina Gaud.
Boehmeria scabrella Gaud.

Moraceae :
Trema orientalis Bl
Ficus arnottiana Mig.
F. bengalensis L.
F. infectoria Roxb.
F. glomerata Roxb.
F. retusa L.

Salicaceae :
Salix tetrasperma Roxb.

Orchidaceae :
Oberonia rupestris Blatter and McCann
Aeridas crispum Lindl.
Habenaria commelinifolia Wall.
H. digitata Lindl.

Zingiberaceae :
Hedychium coronarium Koning
Zingiber macrostachyum Dalz.
Costus speciosus Sm.

Amaryllidaceae :
Curculigo orchioides Gaertn.

Liliaceae :
Smilax macrophylla Roxb.
S. zeylanica L.
Gloriosa superba Linn.

Commelinaceae :
Commelina forskalei Vahl.
Cyanotis axillaris Schult. f.
C. cristata Schult. f.
C. tuberosa Schult.

Palmae :
Caryota urens L.

Araceae :
Cryptocoryne retrospiralis Kunth
Remusatia vivipara Schott.
Arisaema murrayai (Grah.) Hook.

Cyperaceae :
Kyllinga brevifolia Rottb.
K. triceps Rottb.
Carex filicina Nees

Gramineae :
Coix lacryma-jobi L.
Thelepogon elegans Roth
Apluda aristata Linn.
Arthraxon echinatus Hochst.
A. meeboedii Stapf
A. hugelii (Hock.) Camus
Themeda cymbaria Hack.
Iseilema laxum Hack.
Eragrostis stagnina Beauv.
E. nutans (Retz) Nees
Oplismenus burmanni P. Beauv.
O. compositus Beauv.
Isachne lisboae Hook. F.
Sporobolus dianaer Beauv.
Cynodon dactylon Pres.
Eleusine coracana Gaertn.
Dactyloctenium aegyptium Beauv.
Themeda jacquemontit Stapf.
T. lisbboae Stapf.
Bambusa arundinacea Retz.
B. vulgaris Schrad.
Oxytenanthera ritchei
Dendrocalamus strictus Nees

3.5: *Plants of North Kanara found at Koynanagar* :

Dilleniaceae :
Dillenia indica L.

Menispermaceae :
Cissampelos pareira L.

Cruciferae :
Nasturtium officinale R. Br.

Flacourtiaceae :
Flacourtia latifolia Cooke

Dipterocarpaceae :
Hopea wightiana Wall

Malvaceae :
Hibiscus furcatus Roxb.

Bombacaceae :
Bombax ceiba L.

Sterculiaceae :
Helicteres isora L.

Tiliaceae :
Triumfetta rhombifolia Jacq.

Rutaceae :
Toddalia asiatica Lamk
Atlantia monophylla DC

Olecaceae :
Canscora rheedii

Celastraceae :
Salacia prinoides DC
Gymnosporia rothiana Laws

Hippocrateaceae :
Hippocratea obtusifolia Roxb.

Sapindaceae :
Hemigyrosa canesceus Thw.
Sapindus emarginatus Vahl.
Allophylus cobbe Bl.

Anacardiaceae :
Anacardium occidentale L.
Holigarna grahamii Hook
H. arnottiana Hook

Leguminosae (Papilionaceae) :
Crotolaria retusa L.

Capparidaceae :
Nasturtium officinale R. Br.
Cardamine trichocarpus

Fabaceae (Leguminosal) :

Sub-fam-Caesailpinioideae :
Wagatea spicata Dalz.
Bauhinia vahlii W. and A.

Sub-fam-Papilionaceae :
Heylandia latebrosa DC
Crotalaria filipes Benth.
C. mysorensis Roth.
C. retusa L.
Indigofera pulchella Roxb.
Smithia hirsuta Dalz.
S. purpurea Hook.
Aeschynomene indica L.
Alysicarpus rugosus DC.
A. tetragonolobus Edgew.

A. vaginalis DC
Desmodium rotundifolium Baker
D. triflorum (L.) DC
Alylosia lineata W. & A.
Cylista scariosa Roxb.
Pongamia glabra Benth.

Sub-fam-Mimosae :
Entada pursaetha DC

Crassulaceae :
Kalanchoe pinnata Pers.

Combretaceae :
Combretum ovalifolium Roxb.

Myrtaceae :
Syzygium toddelioides Wight

Lacythidaceae :
Caryea arborea Roxb.

Lythraceae :
Rotala indica Koehne
Lagerstroemia speciosa Pers.

Begoniaceae :
Begonia crenata Dryand

Rubiaceae :
Wendlandia thyrsoidea Steud.
Canthium dicoccum Merrill
Ixora nigricans Br.

Compositae :
Gnaphalium leuteo-album L.

Sapotaceae :
Xantolis tomentosa Raf.

Oleaceae :
Olea dioica Roxb.

Apocynaceae :
Alstonia scholaris R. Br.
Tabernaemontana divaricata R. Br.
T. heyneana Wall.

Boraginaceae :
Trichodesma zeylanicum R. Br.
Adelocaryum coelestinum Brand

Solanaceae :
Solanum nigrum L.

Bignoniaceae :
Heterophragma quadriloculare K. Sch.

Acanthaceae :
Dipteracanthus prostratus Nees
Eranthemum purpurascens Nees
Lepidagathis fasciculata Nees
Barleria prionitis L.

Haplanthus verticillatus Nees
Hemigraphis latebrosa Nees var *heyneana*
Justicia trinervia Vahl
J. procumbens L.
Adhatoda vasica Nees

Verbenaceae :
Phyla nodiflora Green
Premna coriacea Clarke

Labiatae :
Dysophylla quadrifolia Benth.
Pogostemon heyneanus Benth.
Anisomeles malabarica R. Br.

Nyctaginaceae :
Boerhaavia diffusa L.

Amaranthaceae :
Aerva lanata L.

Polygonaceae :
Polygonum chinense L. var *ovalifolium*

Piperaceae :
Piper longum L.

Loranthaceae :
Dentropthoe falcata Etting.

4. FLORA OF PUNE DISTRICT

The district of Pune stands on a lofty height 1800′ or more. Climate is breezy ; rainfall and temperature are moderate, determined by the height of the places, but never extreme. Soil is gravelly or mixture of gravel and sand, but nowhere alluvial.

The flora and vegetation of Pune district have been worked out by a number of workers. Several early botanists such as Jacquemont, Gibson, Dalzell, Kirtikar and Cooke (1903—1908) have worked on Pune. Later Blatter and McCann, Santapau, Vartak, Razi and others have described plants of a number of places in Pune district in their writings. This is because Pune had been the headquarters of the Bombay Government during monsoons in the past, and because several Government departments like Forest, Agriculture, Education, Irrigation etc. are located here. The tradition of formal botanical studies at Pune was established by early botanists, Dr. Theodore Cooke, Woodrow, Bhide who had been working here for a long time.

The wall of the Deccan trap hills lies to its north-west and west. When they disintegrate they form murum and produce soils partly sandy and partly sticky having various shades of red or red and black colour. They are generally poor and shallow. In the eastern part of Pune they are dry and poor. As is known the Deccan trap consists of layers after layers of trap and when they disintegrate produce steps-like appearance. This is seen in many places around Pune, but it is highly conspicuous in Sinhagad range of Sahyadris. Pune City stands at the confluence of Mula and Mutha rivers.

The town of Pune also lies at the apex of Mutha river basin or Maval, and it has like other Mavals peculiar climate. The vegetation in the dry

hills is composed of a few trees and shrubs which become conspicuous against the background of dark rocks. Invariably one finds here *Anogeissus latifolia, Ficus glomerata, Hamiltonia suaveolens, Boswellia serrata, Zizyphus rugosa, Dolichondrone falcata, Crissa congesta, Lavendula vera, Carvia callosa, Ficus arnottiana, Woodfordia fruticosa.* At higher altitude above 3000′ the flora changes to semi-evergreen and sometimes forms evergreen pockets in ravines.

The terrain throughout this district is undulating. The northern and western parts are beset with hills from the spurs of Sahyadris ; their high peaks are all isolated e.g. Rohideshwar, Purandar, Sinhagad, Bhimashankar, Shivaneri etc. On many of these peaks there are hill forts separated from each other. They have preserved some rare species in their enclosures. The peaks though isolated from each other have similar vegetation due to similar rainfall, temperature range and soil. They are possibly the fragments of old continuous vegetation in distant past, but now discontinuous, because the trap rocks between them are disintegrated and washed away. They do not have uniformly hard or soft basalt. Therefore, they form gullies and valleys which later get filled with earth and vegetal matter from the upper flats.

4·1: Previous work on the Flora of Pune:

Pune district has varied terrain from the edge of Sahyadris at the north and north-west. It is nearly flat and arid in the low rainfall area. *Acacia* tract lies to the south and south-east near Daund, Indapur, Yavat and Shirur. The flora naturally is varied. Flora of the remaining region between the two regions, east and west, lies in the medium rainfall Zone The flora of Khandala, Ambavane and Sakharpathar, Mulshi. Bhimashankar has been developed in the high rainfall region, whereas, that of Daund, Shirur and Pune has developed in the arid low rainfall region. Flora of Pune, Talegaon, Purandar, Junnar is in the medium rainfall region.

Pune has been the headquarters of the Botanical Survey of Western India ever since it was started in 1890—1893, and was restarted in Pune in 1956. The Western Circle of it is in Pune. Dr. Gibson, Dr. Cooke, Prof. Woodrow, Dalzell and a number of other botanists such as Gammie, Stocks, Bhide, Kanitkar, H. P. Paranjape, Santapau and Vartak worked on Pune plants and also the members of the Agriculture and Forest Departments, and those in the Botanical Survey of India. The Flora of Pune district on account of their efforts, is better known than that of many other districts. But there is no comprehensive account of the Flora of the Pune district as a whole. Therefore, flora of the representative areas in the three rainfall regions only would be described here. Plants of Pune and surroundings are frequently mentioned by Cooke (1901 —1908) in his *Flora of the Bombay Presidency*, but a more comprehensive account of the plants of Pune district and surrounding hilly regions is given by Razi (1952). Since this is a fairly detailed and recent list of plants of Pune, it is given briefly below.

Razi (1952) has also made some general observations on the forests of Pune which, according to him, belong to three classes : (1) forests in the hilly region, (2) forests on the river banks, and (3) upland reserved forests, Government as well as private. The private reserved forests are mostly in the hilly tract of Maval and Mulshi to the west of Pune. The valleys of Maval and higher slopes of Sahyadri ranges in the district have small evergreen or semi-evergreen forests, but due to several hill forts having been constructed on the crests of Sahyadris, the forests around

them were destroyed to avoid hiding by enemies. The second category of forests are the close strands of *Acacia arabica*, *Syzygium jambolana*, *Pongamia glabra on* the banks of rivers cutting their way through Maval region and flowing to the east in their basins. The third class of these forests are in the highland region of Maval, Mulshi, Ambavane and Khandala. They are both Government and private. In other parts in the plains and on the low hills there are deciduous forests.

The deciduous forests of Pune have also been studied by Garland (1933), by Puri and Vasavda (1957),Qureshi (1962), Mahajan, Jain, Ansari and others. Jain and Hemadri have collected several grasses, as there are many pasture lands in the vicinity of Pune, right up to Talegaon on one side and up to Purandar on the other side. Plants of hills around Pune have been studied by Vartak (1957—1959). He has also drawn attention to many interesting plants of Pune and Satara districts and has described the flora of Katraj. The trees within the Pune Municipal Corporation area and plants of Mutha river bed have also been described by him (1957—1964) besides some grasses (1973). Earlier Ezakiel (1916) had described the plants and ecology of the Chatushringi hill reserve forest. Several members of Agriculture Department have described the grasses, legumes and some useful plants of this region, especially Dr. Burns, Kulkarni and Godbole (1925—1931). The flora of Ganeshkhind area has been described by Varadpande (1973).

An important feature of the Pune district is the hill forts. The flora of these is better preserved within the fort walls, and Santapau (1957) has described the flora of Purandar, Torna and Sinhagadh. He (Santapau 1966) has given a comprehensive account of the flora of the hill forts in Maharashtra in general. Vartak (1953) has described the flora of hill fort Rajgad. Earlier a more detailed account of the grasses of Pune has been included by Blatter and McCann (1925) based on Bhide's collection. Razi (1952) has enlisted them further.

In the hilly regions of Pune, there is high rainfall generally on the crests, but plains have low or medium rainfall on account of which they have sparse deciduous forests and scrub. The trees common are *Mangifera indica, Lagerstroemia parviflora, Adina cordifolia, Salmalia malabarica Tectona grandis.* In moist deciduous forests *Tectona grandis, Terminalia bellerica, Grewia tiliaefolia, Boswellia serrata, Terminalia tomentosa* merge into semi-evergreen forests, and in arid region they get mixed with scrub formed by *Gymnosporia marginata, Carissa congesta*, etc. The scrub consisting of *Acacia leucophloea* gets merged with open grasslands found throughout the district in medium and low rainfall regions. However, there is no systematic effort to introduce new grasses or to know of the conditions under which they could be regenerated. Dr. Razi (1952) has drawn attention to these open grasslands as an important feature of the flora of Pune district.

Among the high rainfall region, the flora of Khandala has been thoroughly worked out by Santapau (1957) and the plants of Ambavane-Sakharpathar have been enlisted by Reddi (1970). The account of the medicinal plants of Khed taluka and plants of Bhimashankar has been given by Janardhanan (1963). The plants of Junnar were studied by K. Hemadri but the work is unpublished.

The district contains some rare plants and endemics. The best known of these *Frerea indica* is found in the ledges of rocks and on fort walls at Junnar. Recently this plant has been rediscovered at Mahabaleshwar

below the Kate's point by McCann and in the crevices of rocks of Vazirgad in Purandar fort by Santapau. This is a member of the Asclepidaceae looking like a cactus and has very showy flowers. It is a world endemic but is fast on way to extinction. There are many species of *Ceropegia* described as new by Ansari (1968—1972). A new genus of the same family called *Seshagiria* has been described by Hemadri, Ansari and others. The deciduous forests of Pune district are also described by Puri and Vasavda (1957). There was an exquisite Forest Park, developed on about 40 hectares of land at the base of hilly region in the bend of Kukdi river at Hiwre (Junnar taluka). This was started by Dr. Alexander Gibson in 1840, wherein he developed a method of blending exotic trees and bushes with those naturally occurring here, but to the great dismay of botanists this park is now submerged under the lake formed by the high level dam on the Kukdi river, and thus the work of a pioneering botanist and forester of rare attainments of the stature of Dr. Gibson has come to a sad end !

Important papers dealing with the flora of Pune district are given below after the account of erstwhile Gibson's Park.

4·2 : Rainfall regions of Pune and their flora :

The flora of Pune district has been concentrated in three markedly different regions :

1. Dry eastern low rainfall region-beyond Yavat upto Daund, Pomalvadi, Shirur, where the rainfall is 33"—35" or less, not more than 34" as a rule. Soils are mostly gravelly. This is a low rainfall area.

2. High rainfall area to the west and north-west adjacent to Sahyadris.—Rain in this region at places exceeds 200", but generally at most of the places, it is 50—100". The region faces ghats and overlooks Konkan. It gets more rain because Sahyadri blocks clouds (Bhor, Rohideshwar, Mulshi, Ambavane, Khandala, Bhimashankar, Sakhar-Pathar). Rainfall in this region, mostly Mavals, is high. Like trap layers, vegetation is banded alternating with traps e.g. in Bor Ghat near Khandala.

3. Medium rainfall region or the Intermediate region having 48"—50" of rain. Pune, Junnar, Talegaon, Urali-Kanchan lie in it.

The first region above is dominated by *Acacia, arabica var Ramkathe, Flacourtia ramontia* and low shrubs of *Capparis grandis*. Next to Andhra Pradesh Acacia tract this is another typical Acacia tract. It lies in the basin of Bhima river and is mostly dry throughout the year. The ratio of dry to humid period is 9:3 and that determines the arid or semi-arid nature of the region.

The first region receives heavy monsoons for about 5 months, July and August being the wettest months. It has moist deciduous or semi-evergreen forests dominated by *Anogeissus latifolia, Terminalia tomentosa, T. chebula, Mitragyna parviflora, Mangifera indica*. At higher altitude the valleys and ravines contain evergreen species of *Actinodaphne hookeri, Garcinia indica, Lagerstroemia parviflora, Grewia undiflora, T. ramontchia, T. arnottiana*, and several herbaceous members of the *Rubiaceae, Leguminosae*, *creepers* of *Combretum, Glochidion hohenakeri, Gmelina arborea, Ceiba malabarica, Syzygium cumini* etc. *Tectona grandis* as a rule is not present in evergreen forests, as it needs some dry period for full growth.

Some of these forests merge in semi-arid areas into dry deciduous forests in which *Lannea grandis, Tectona grandis* occur. In open spaces, wastelands, gravel, poor soil, highly eroded places and slopes, only grass grows. There are extensive open grasslands around Pune at Katraj, Talegaon, Shirur, Pomalvadi, Junnar, but only in rainy season. Grass lasts till about January. They serve as pastures. Their ecology has been studied by Burns et. al (1925, 1931). In medium rainfall region there is scrub jungle in which *Acacia leucophloca, Rhus mysorensis, Flacourtia ramontia, F. macrophylla, Woodfordia fruticosa* occur here and there. Thus the vegetation of the three regions looks different from each other. Flora of the more important typical places in each, is described here as representative of these regions.

4.3 : *Flora of Chatushringi and Vetal Hills* :

Chatushringi and Vetal hills are close to Pune University Campus separated by a road going to Government House, and thence to Aundh village. They are typical trap hills, dry, and with little or on soil on top flats. They lie in medium rainfall region, and as such, are semi-arid. A number of xerophytes, shrubs, herbs and a few trees of *Acacia leuoephloea, Rhus mysorensis, Dolichondrone falcata* grow on them, with grasses. Some leguminous herbs grow on them during rainy season. Drought period extends for about eight months. During summer they all dry up and only trees remain here and there. Tuberous plants, creepers, some calcicoles persist with a few petrophytes but all the rest of ground flora dies.

Ezakiel (1947) has worked on the ecology and flora of Chatushringi forest reserve. The common surface herbaceous flora towards the end of rainy season consists of *Tridax procumbams, Boerhavia diffusa, Echinops echinatus, Indigofera linifolia, Polygala erioptera, Linaria ramosissima, Evolvulus alsinotides, Striga luteota* and other species like *Justicia diffusa, Sopubia delphinifolia, Phyllanthus niruri, Mimosa hamata* etc. Mixed with these there are succulent plants like *Sarcostemma brevistigma, Cynotis tuberosa, Cynotis axillaris, Caraluma fimbriata, Asparagus recemosus*. Lians like *Vitis repanda, Vitis woodrowii, Vitis setosa, Hemidesmus indicus grow* mixed with them. Straggling on *Acacia leucophloea* and other trees are *Ceropegia tuberosa, Dragea volubilis, Leptadenia reticulata, Rivea hypercrateri formis. Scilla indica, Chlorophytum tubererum, Ophioglossum aitchisoni.* The trees of *Bauhinia racemosa, Dolichondrone falcata* are few and fewer still are the trees of *Tectona grandis,* but the bushes of *Rhus mysorensis* are many.

These hills form typical dry thorny scrub. Similar vegetation is seen in semi-arid region in many places in Maharashtra, and particularly in low rainfall zone around Pune.

4.4 : *Flora of Ganeshkhind Area* :

Opposite the Chatushringi hill lies the Range hill in Ganeshkhind (18°34′N Lat. 73°53′ E Long.) in the Poona University Campus. It is separated by a road leading to Government House and Pashan. The area of the University campus is 412 acres. It is a plateau, a kind of pediment surface in which the Tertiary basalt of amygdaliodal type is seen and also some compact hard basalt in a few places. The soil is poor, alkaline, and it is mostly derived from sand and gravel. June to October is rainy season, there being about 50 rainy days, and total rainfall is about 40″. December-January are the coldest months when the temperature

rarely reaches to 4° C. April-May are the hottest when it reaches 39°-41° C. There is great variation in day and night temperatures upto 20°C. Thunder showers are occasional in April and May. Relative humidity varies from 20% in the morning to 71-78% in the afternoon. The direction of the wind is generally south-west to north-east.

Vegetation.—According to Varadpande (1973) there are 780 species spread over 540 genera and 118 families. Dicots constitute 415 genera and monocots 96. Families Leguminosae, Compositae, Euphorbiaceae, Graminae are the large families here.

The vegetation except on the Range hill and in the small valley at the north is xerophytic and is a kind of scrub made up of *Acacia chundra, A. nilotica, A. leucophloea, Dalbergia melanozylon, Dolichandon falcata, Dichrostachys cineroa, Capparis grandis, Zizyphus mauritiana* and such other deciduous trees. There are a large number of ephemerals and thorny bushes of *Securinega leucophyrus, Meytenius senegalensis, Mimosa hamata, Ehretia aspera*. In the central area there are hard rocks fully exposed. But in the low lying areas there are many *Acacia* sp., *Albizzia lebbek* and thickets of *Dalbergia melanoxylon*, which are self born.

In the monsoons many ephemerals such as *Heliotropium ovalifolium Cyanotis fasciculata, Oldenlandia corymbosa, Glassocardia Boswellea*. appear. On the hill there are a few lingering trees of *Tectona grandis* and *Boswellea serrata* alongwith newly planted *Gliricidia maculata*. But they are only few. The hill was probably previously covered by trees but became quite barren later. The eastward side of it is now covered by newly planted *Gliricidia maculata* and other trees replanted as a part of afforestation scheme of the University, under, the the Botany Department. In the ledges of rocks *Chlorophytum nimmonii, C. tuberosum, Urginea indica* spring up during rains. On the plain ground *Iphigenea indica, Cyanotis tuberosa, Cyperus triceps, Maelanocenchis jacquemontii, Ophioglossum nudicaule, O. gramineum, Chlorophytum laxum* come in succession. Of these *Ophioglossum gramineum* and *Chlorophytum tuberosum* come at the same time, but are rare. Many trees of *Capparis grandis and Dalbergia latifolia* and *Serotina siliqua* (Carob) and other introduced trees form a thick belt of vegetation.

A very remarkable feature of the area is the mixture of exotic trees such as *Adansonia digitata, Brownea* sp. *Erythrina indica, Collvillea racemosa, Gmelina arborea, Brassiea umbellata*. They form a formal garden and merge with the natural vegetation. The whole area makes a landscape garden. The place, though typically xerophytic, merges with the exotic plants, so planted as to have some trees with flowers every month, This was probably done at the suggestion of Dr. Gibson, Superintendent of Botanical Garden then at Dapodi.

The whole area was designed by Sir Humphrey Repton as a 19th century English landscape garden with undulating grassy plains, shrubby paths lined by African bush, *Dalbergia melanoxylon*, a thick woodland towards the low lying valley in the middle. This leguminous bush gets completely defoliated in winter, looks dry and denuded in summer, but with the advent of first rains, it produces millions of small white fragrant flowers in great profussion on otherwise leafless bushes. In other months it is all green and presents pleasant green appearance. They change to yellow before leaf-fall in winter. The whole thing gives an appearance of English landscape. The paths resemble with the backs of the colleges in Cambridge and Oxford.

The old Government House is now Poona University Building and Senate Hall. It contains many frescoes of English plants, coat of Arms and emblems of early British Governors in the last century. This is perhaps the only place where 19th century English landscape garden wherein formal garden and natural vegetation are blended together into landscape simulating the Blenheim Palace near Oxford with all its English effects. The list of important exotic plants mixed with natural vegetation is marked with *asterisk* in the list below.

A significant feature of the Ganeshkhind Botanical Garden is a huge tree of banyan, *Ficus bengalensis*. It has 25-30 stumps of stilt roots, and is spread over about half a furlong in expanse reminding one of the famous banyan grove spread over an acre in Indian Botanical Gardens at Shibpur, Calcutta, or the banyan near Pachvad on way to Wai from Satara, or the famous *Kabir Vad* near Bharuch.

A list of selected plants is given after Varadpande (1973).

Ranunculaceae :
Clematis trilaba Heyne

Berberidaceae :
**Nandina domestica* Thunb.

Capparidaceae :
Cadaba fruticosa Druce
Maerua arenaria Hook.

Bixaceae :
Cochlospermum gossypium DC.
Flacourtia indica Merr.

Malvaceae :
Sida verenicifolia Lamk.

Bombacaceae :
Bombax ceiba Linn.
**Adansonia digitata* Linn.
Ceiba pentandra Gaertn.

Zygophyllaceae :
**Guaiacum officinale* Linn.

Oxalidaceae :
**Averrhoa carambola* Linn.

Geraniaceae :
Monsonia senegalensis Guill and Perr.

Rutaceae :
**Rivinia spectabilis* Griseb.

Ochnaceae :
**Ochna squarrosa* Linn.

Burseraceae :
Boswellia serrata Roxb.
Garuga pinnata Roxb.
**Bursera delpechiana* Peiss.

Celastraceae :
Gymnosporia montona Benth.
Elaeodondron roxburghii Wt. and Arm.

Rhamnaceae :
Zigyphus mauritiana Lamk.
Z. xylopyra Willd.

Sapindaceae :
**Filicium decipens* Thw.

Anacardiaceae :
Rhus mysurensis Heyne
Lannea coromandelica Merr.

Papilionaceae :
**Crotolaria juncea* Linn.
Crotolaria mysorensis Roth.
Melilotus alba Desr.
Psoralea corylifolia Linn.
Tephrosia strigosa Santapau and Mahesh.
**Milletia ovalifolia* Kurz.
Butea monosperma Taub.
Dalbergia sissoo Roxb.
**D. melanoxylon* Guill
D. latifolia Roxb.
D. lanceolaria Linn.
**Gliricidia sepium* Steud.

Caesalpiniaceae :
Caesalpinia sepiraia Roxb.
**Delonix elata* Gamble

Rhizophoraceae :
**Carallia brachiata* Merr.

Combretaceae :
Terminalia tomentosa Wt. and Arn.
**Anogeissus pendula* Eedgew.

Myrtaceae :
Syzygium cumini Skeels
**Callistemon lancealatus* DC
**Melaleuca leucadendron* Linn.

Lecythidaceae :
Careya arborea Roxb.

Melastomaceae :
Memecylon umbellatum Burm.

Lythraceae :
Woodfordia fruticosa Kurz

Cactaceae :
**Pereskia grandiflora* Hort.

Caprifoliaceae :
**Lonicera japonica* Thumb.

Rubiaceae :
**Pentas lanceolata* K. Schum.
Gardenia resinifera Roth.
**Coffea arabica* Linn.

Compositae :
Vernonia cinerosa Less.
Ageratum conyzoides Linn.
Artemisia nilgeirica Pamp.
**Acanthospermum hispidum* DC.
**Parthenium hysterophorus* Linn.
Senecio grahami Hook.
Solidage canadensis Linn.

Campanulaceae :
Isotoma longifolia Juss.

Plumbaginaceae :
Plumbago zeylanica Linn.
P. rosea Linn.

Sapotaceae :
**Chrysephyllum cainite* Linn.

Ebenaceae :
Diespyros peregrina Gurke.
D. mentana Roxb.

Myrsinaceae :
**Jacquinina ruscifolia* Spreng.

Oleacea :
Olea europaea Linn.
**O. fragrana* Linn.

Apocynaceae :
Rauvolfia canescens Linn.
R. serpentina Benth.
Vallaris solanacea Kuntze
Beaumontia grandiflora Wall.
Alstonia scholaris R. Br.
Holarrhena antidysenterica Wall.
Wrightia tomentosa Roem. and Schutt.
W. tinctoria R. Br.
**Aganosoma carophyllata* G. Don.
**Roupellia grata* Wall. and Hook.
Trachelospermum fragrans Hook.

Asclepiadaceae :
Hemidesmus indicus Schult.
Cryptolepis buchanani Roem. and Schult.
Pergularia daemia Choiv.
Sarcostemma brevistigma Wight.
Dregea volubilis Benth.
Ceropegia hirusta Wt. and Arn.
C. bulbosa Roxb.
Caralluma fimbriata Wall.
Cryptostegia grandiflora R. Br.
**Stapelia grandiflora* Masson
Frerea indica Dalz.

Loganiaceae :
Buddleja asiatica Lour.
B. madagascariensis Lamk.

Gentianaceae :
Exacum pumilum Griesb.

Convolvulaceae :
Porama paniculata Roxb.
P. racemosa Roxb.
Rivea hypocrateriformis Choisy.

Solanaceae :
Withania sonmifera Dunal.
Datura arborea Linn.
**Brunfelsia americana* Linn.

Scrophulariaceae :
Veruascum chinense Santapau
Kickxia ramosissima Janchen.
Striga gratica Linn.
S. densiflora Benth.
S. angustifolia Sald.
S. asiatica Kuntze.
Sopubia delphinifolia G. Don.

Bignoniaceae :
Dolichandrane falcata Seem.
Heterophragma quadriloculare K. Schum
**Millingtonia hortensis* Linn.
**Spathodea campanulata* Beauv.
**Kigelia pinnata* DC.
**Jacaranda mimosifolia* D. Don.
**Crescentia cujete* Linn.
**Tabebuia pentaphylla* Hemsl.
T. rosea DC.
Adenocalymma nitidum Maxt.

Acanthaceae :
Andrographis echioides Nees
Securinega leucopyrous Muell-Arg.
Cicca acida Merill.
**Phyllanthus distichus* Muell-Arg.
Putranjiva roxburghii Wall.
Codiacum variegatum Blume.
**Manihat esculenta* Grantz
Excoecaria bussei Pux.
E. bicolor Hassk.

Orchidaceae :
Habenaria marjinata Coleb.
Eulophia pratensis Lindl.

Musaceae :
Musa paradisiace Linn.
**Strelitzia reginae* Bank.
**Heliconia angustifolia* Hook.

Zingiberaceae :
Glabba bulbifera Roxb.
Costus speciosus Smith.

Agavaceae :
**Yucca gloriosa* Linn.

Dioscoreaceae :
Dioscorea alata Linn.

Liliaceae :
Asparagus racemosus var. *javanica* Baker.
A. virgadus Baker.
Gloriosa superba Linn.
Iphigenia indica A. Gray.
I. pallida Baker.
J. diffusa Willd.
Peristrophe bicalyculata Nees.

Verbenaceae :
Citharexylum subserreatum SW.
**Holmskioldia sanguinea* Retz.
**Petrea volubilis* Linn.

Labiatae :
Lavandula burmanni Benth.
Origanum majorana Linn.
Pogostemon heyneanus Benth.

Amaranthaceae :
Aerva lanata Juss.
Gomphrena cebsioides Martr.

Chenopodiaceae :
Spinacia aleracea Linn.

Piperaceae :
Peperomia wightiana Miq.

Lauraceae :
**Persea gratissima* Gaertn.

Proteaceae :
**Grevillea robusta* A. Cunn.

Loranthaceae :
Dendropthoe falcata Etting.
Viscum nepalense Spreng.

Santalaceae :
Santalum album Linn.

Euphorbiaceae :
Bridelia squamosa Gehrm.
Scilla indica Baker.
Urginea indica Kunth.
Asphodelus tenuifolius Cav.
Chlorophytum tuberosum Baker
C. laxum R. Br.
C. orchidasbrum Lindl.
**Dracaena fragrans* Ker. Gawl.

Commelinaceae :
Cynotis axillaris Schutt.

Palmae :
**Arecastrum roman afflanum* Bell.
**Syagrus coronata* Bell.
**Chrysalidocarpus lutescems* Wendl.
**Cocathrinax argentea* Schum.
**Elaeis guineensis* Jaig.
**Licuala grandis* Wendl.

**Sabal palmetta* Ladal.
**S. adansoni* Guers.
**Rhapis doabelliformis* L'Her.
**R. humilis* Blume
**Caryota sabolifera* Wall.
**C. mitis* Lour.

Cyclanthaceae :
**Carludovica palmata* Ruitz. and Pav.

Araceae :
**Philodendron giganteum* Schott.
**Monstera deliciosa* Liebrn.

4·5: Flora of Katraj Ghat :

About 13 km from Pune to the south is Katraj ghat, on Pune-Bangalore National highway, 1600′ above Pune plain. The pass at the tunnel is 3000′ high. It lies at 18°27′N Lat. and 73°52′ E Long. The Katraj ghat area is 10 sq miles. It lies on a east-west range of Sahyadri. It has two peaks, the north peak being 3779′ and south peak 3703′ above M.S.L. They block the clouds. North peak naturally gets more rain. Katraj village has an altitude of 2290′ above M.S.L. The tunnel is in between the two peaks in the saddle and commands a glorious view of Pune city. There are two small tanks or lakes known as Mastani's Talav, and an aquaduct at Katraj which supplies water to Pune City.

The hill is a trap hill with 4—6 lava flows traversed by sills and dykes. Rainfall is 28″-34″, generally 33-34″. Much of it falls in July, August and September. Winds are mostly westerly. There are two ravines on northern slopes. Soil is sandy and not deep. The vegetation, here is determined by poor soil altitude, direction of wind and rainfall, but is also limited by biotic factors, being quite near to Pune city.

Mostly the shrubs of *Gymnosporia montana, Zizyphus rugosa, Carissa congesta, Argyreia cuneata, Securinega leueopyrus, Osyris wightiana* are in evidence. The whole vegetation is of dry deciduous type. Quite a number of grasses grow here which dry up and hills look barren in summer.

Soon after rains many tuberous herbs like *Chlorophytum tuberosum, Dipcadi ursulae, Cynotis fasciculatus* begin to appear and rich monsoon flora develops on flats on hills. On the hill top flats *Hypoxis aurea, Chlorophytym laxum C. tuberosum, Seilla indica, Iphigenia pallida, Costus speciosum,* appear. On way to top one notices *Woodfordia fruticosa, Clematis triloba, Anisomeles malabarica, Senecio edgeworthii, Pimpinella monoica,* whereas on the topmost flats in crevices of rocks one sees *Adiantum caudatum, Actinopteris dichotoma, Urginia indica, Linum mysurense, Cassia mimosoides, Habinaria grandiflora, H. crassifolia,* several grasses like *Apluda aristata, Aristida faciculata, Heteropogon insignis, Thelepogon elegans* occur.

In the ghat *Capparis grandis, Ceiba malabarica, Schrebera swietenioides, Caesalpinia bondualla, Cryptolepis buchunani* are found. Two most remarkable plants in the ghat are *Lannea grandis* and *Coclospermum gossypirum* : on higher parts *Anogeissus latifolia* is seen. Many weeds like *Parthenyum histeroforus* and *Acanthospermum hispidum* have invaded ghat area through man.

Dr. Vartak (1960) has collected about 600 species here, the more important of which are enlisted below. Ratio of dicots to monocots is 3.1 : 8, the important families and species number-wise are Leguminosae (87), Gramineae (80), Compositae (48), Euphorbiaceae (25), Cyperaceae (22), Scrophulariaceae (17), Asclepiadaceae (16), Acanthaceae (17), Labiatae (16).

Deciduous species, so common all over Deccan like *Tectona grandis* or *Boswellia serrata* are present here, but not in dense formation due to aridity. At the same time plants like *Coleus barbatus*, *Vernonia indica*, *Habernara crassifolia* which are very common at cool places like Panchgani or Mahabaleshwar also occur here at the highest plateau on the hill tops. The vegetation in ravines and valleys is dominated by *Boswellia serrata*, second story dominants are *Anogeissus latifolia*, *Lannaea grandis*, *Ougenia dalbergioides*, *Diospyros melanoxylon*, *Buchanamia lanzan*, *Sterculia urens*. They are indicative of dry conditions. On the other hand *Semicarpus anacardium*, *Schleichera oleosa* are humid species. Obviously the flora is not purely of dry deciduous type. The flora of Katraj, though lies in medium rainfall zone, is remarkable. Grasses here provide ample feed for cattle and contain moist soft as well as woody species.

Table showing relative position of families and species at Katraj as compared with those in India.

Serial No. (1)	Katraj Hills (2)	Species (3)	Position in India (4)	Western peninsula (5)
1	Leguminosae	86	2	2
2	Gramineae	80	3	1
3	Compsitae	48	7	8
4	Euphorbiaceae	25	5	6
5	Cyperaceae	22	8	5
6	Scrophulariaceae	17	..	..
7	Acanthaceae	16	..	10
8	Asclepiadaceae	16	6	3

List of Plants in Katraj Ghat Area (after Vartak 1960)

Menispermaceae :
Cissampelos pareira Linn.
Stephania hernandifolia Walp.

Cruciferae :
Cardamine trichocarpa Hochst.

Capparidaceae :
Maerua ovalifolia Cambess.
Capparis zeylanica Linn. (=*C. horrida* Linn.)
Capparis grandis Linn.

Caryophyllaceae :
Polycarpaea corymbosa Lam.

Elatinaceae :
Bergia ammannioidas Roxb.

Malvaceae :
Kydia calycina Roxb.
Urena lobata Linn. (=*U. sinuata* Linn.)
Abelmoschus esculentus Moemseh.
=*Hibiscus esculentus* Linn.

Bombacaceae :
Salmalia malabarica Schott.
=*Bombax malabaricum* DC.

Tiliaceae :
Grewia tiliaefolia Vahl.
G. pilosa Lam.
G. hirsuta Vahl.

Linaceae :
Linum mysorense Heyne.

Malpighiaceae :
Aspidopterys cordata A. Juss.
Monsonia senegalensis Guill.

Balsaminaceae :
Impatiens balsamina Linn.
Var. *rosea* Lindl.

Rutaceae :
Murraya koenigii Spreng.

Simarubaceae :
Alianthus excelsa Roxb.

Burseraceae :
Boswellia serrata Roxb.

Meliaceae :
Cipadessa fruiticosa.
Heynea trijuga Roxb.

Celastraceae :
Celastrus paniculata Willd.
Gymnosporia montana Benth.
Elaeodendron glaucum Pers.

Rhamnaceae :
Zizyphus oenoplia Mill.
Z. rugosa Lamk.

Ampelidaceae :
Cissus woodrowii Santapau.
(=*Vitis woodrowii* Stapf.)
C. setosa Roxb.
Leea robusta Roxb.
(=*L. aspera Edgew.*)
L. sambucina Willd.

Sapindaceae :
Schleichera trijuga Willd.

Anacardiaceae :
Rhus mysurensis Heyne.

Papilionaceae :
Crotolaria filipes Benth.
C. mysorensis Both.
C. triquetra Dalz.
C. calycina Serank.
C. juncea Linn.
Crotolaria medicaginea Lamk.
Indigofera linifolia Retz.
I. cordifolia Heyne.
I. glandulosa Willd.
I. enneaphylla Linn.
I. hendecaphylla Jacq.
I tinctoria Linn.
I. pulchella Roxb.
Tephrosia senticosa Pers.
T. purpurea Pers.
Sesbania bispinosa Fawcett.
(=*S. eculeata* Pers.)
Smithia conferta Sn.
S. purpurea Hook.
Alysicarpus monilifera Edgew.
A. vaginalis DC. Var. *etyracifolius* Baker.
A. tetragonolobus Edgew.
A. bupleurefolius DC.
Ougeinia dalbergioides Benth.
Teramnus labialis Spreng.
Mucuna prurita Hook.
(=*M. pruriens* DC.)
Erythrina stricta Roxb.
Butea monosperma O. Kuntze.
(=*B. frondosa* Konig.)
Canavalia gladiata DC.
Phaseolus khandalensis Santapau.
(=*P. grandis* Dalzell).
Atylosia searabaeoides Benth.
=*Cylista scariosa* Roxb.
Rhynchosia minima DC.
Dalbergia sissoo Roxb.
D. latifolia Roxb.
D. lanceolarea Linn.
Pterocarpus marsupium Roxb.

Caesalpinaceae :
Cassia fistula Linn.
Hardwickia binata Roxb.
Bauhinia racemosa Lamk.

Mimosaceae :
Acacia leucophloea Willd.
A. catechu Willd. Var. *sundra* Prain.
Albizzia lebbeck Benth.
A. odoratissima Benth.
A. amara Boiv.

Combretaceae :
Terminalia bellerica Roxb.
T. crenulata Roth.
(=*T. tomentosa* Cooke).
Anogeissus latifolia Wall.
Combretum extenbum Roxb.

Myrtaceae :
Eupenia jambolana Lamk.

Lythraceae :
Rotala tenuis Koehme.
(=*Ammania tenuis* Clarke).
Woodfordia fruticosa Kurz.
(=*W. floribunda* Salisb.)
Lagerstroemia parviflora Roxb.

Onagraceae :
Jussiaea suffruticosa Linn.

Cucurbitaceae :
Corallocarpus epigaeus C. B. Clarke.

Begoniaceae :
Begonia crenata Dryand.

Molluginaceae :
Mollugo pentaphylla Linn.

Umbelliferae :
Pimpinella monoica Dalz.
P. adscendens Dalz.
Heracleum concanense Dalz.

Rubiaceae :
Dentella repens Forst.
Mitragyna parviflora Korth.
Morinda tinctoria Roxb. Var. *tomentosa* Hook.
Hamiltonia suaveolens Roxb.
Borreria stricta Schum.
(=*Spermacoce stricta* Linn.)
Hymenodictyon excelsum Wall.

Compositae :
Vicoa indica C. B. Clarke.
Ageratum conizoides Linn.
Blumea lacera DC.
B. membranaceae DC.
B. oxyodonta DC.
Xanthium strumarum Linn.
Sclerocarpus africanus Jacq.
Artemesia parviflora Buch-Ham.
Notonia grandiflora DC.
Senecio edgeworthii Hook.
S. grahami Hook. f.
Echinops echinatus Roxb.
Acanthospermum hispidum DC.
Parthenium hysterophorus Linn.

Lobeliaceae :
Lobelia alsinoides Lamk.

Campanulaceae :
Cephalostigma schimperi Hochst.
C. flexuosum Hook.

Plumbaginaceae :
Plumbago zeylanica Linn.

Myrsinaceae :
Embelia robusta Roxb.

Ebenaceae :
Diospyros melanoxylon Roxb.

Apocynaceae :
Carissa congesta Wight.
(=*C. carandas* Graham).
Holarrhena antidysentrica Wall.
Wrightia tomentosa Roem.

Asclepiadaceae :
Pergularia daemia.
(=*Daemia extensa* R. Br.)
Holostemma annulares K. Sch.
(*H. rheedianum* Spreng.)
Cynanchum callialata Han.
Tylophora dalzellii Hook.
Sarcostemma intermedium Decne.
Marsdenia tenacissima Wight.
M. volubilis T. Cooke.
Ceropegia hirsuta W. and A.
Ceralluma fimbriata Wall.
Cryptostegia grandiflora R. Br.

Gentianaceae :
Canscora diffusa R. Br.
Swertia minor T. Cooke.

Convolvulaceae :
Ipomoea calycina C. B. Clarke.
I. muricata Jacq.
(=*Calonyction muricatum* Don.)
I. obscura Ker-Gawl.
I. batata Poir.
I. palmata Forsk.
I. coccinea Clarke.
Rivea hypocrateriformis Choisy.
Argyreia cuneata Ker-Gawl.
Jacquemontia paniculata Halsier.

Solanaceae :
Solanum indicum Linn.

Scrophulariaceae :
Verbascum coromandelianum Kuntz.
(=*Celsia coromandeliana* Vahl.)
Kickxia ramosissima Janchen.
(=*Linaria ramosissima* Well.)
Lindernia hissoplodes Hainer
Lindernia ciliata Pennell.
(*Bonnaya brachiata* Link.)
Striga gesnerioides Vatke.
(=*S. orobanchioides* Benth.)
S. densiflora Benth.
S. asiatica Kuntze.
(=*S. lutea* Lour.)
Rhampicarpa longiflora Benth.
Sopubia delphinifolia G. Don.

Centranthera nepalensis D. Don.
(=*C. hispida* R. Br.)

Lentibulariaceae :
Urticularia flexuosa Vahl.
U. uliginosa Vahl.

Bignoniaceae :
Dolichondrone falcata Seem.
Heterophragma quadriloculare Schum.
(*H. roxburghii* DC.)

Acanthaceae :
Dicliptera micrantha Nees.
Ruellia patula Jacq.
Andrographis echioides Nees.
Barleria prionitis Linn.
B. gibsoni Dalz.
Justicia quinqueengularis Koen.
Adhatoda vasica Nees.
Peristrophe bicalyculata Nees.

Verbenaceae :
Lantana camara Linn.
Var. *aculeata* Moldenke.
Tectona grandis Linn.
Gmelina arborea Roxb.
Vitex negundo Linn.
Clerodendron phlomidis Linn.
C. serratum Spreng.

Labiatae :
Ocimum canum Sims.
Coleus barbatus Benth.
Lavandula bipinnata O. Ktze.
(=*L. burmanii* Benth.)
Anisomeles malabarica R. Br.
Plectranthus mollis Sprang.
(=*P. incanus* Link.)
Leonotis neptifolia R. Br.

Amaranthaceae :
Amaranthus paniculatus Linn.
Aerua lanata Juss.

Chenopidiaceae :
Chenopodium album Linn.

Polygonaceae :
Polygonum plebejum R. Br.

Loranthaceae :
Dendropthoe falcata Etting.
(=*Loranthus falcatus* Linn.)
Viscum angulatum Heyne.
Taxilus cuneatus Spreng.

Santalaceae :
Santalum album Linn.
Osyris wightiana Wall.
(=*O. arborae* Wall.)

Euphorbiaceae :
Euphorbia acaulis Roxb.
E. antiquorum Linn.
E. elegans Spreng.
Euphorbia hirta Linn.
(=*E. pilulifera* Hook.)
E. thymifolia Linn.
E. tirucalli Linn.
E. katrajensis Sant.
E. geniculata Orteg.
Givotia rottleriformis Griff.
Bridelia squamosa Greham.

Ulmaceae :
Holoptelea integrifolia Planch.
Trema orientalis Blume.

Moraceae :
Ficus retusa Linn.
F. arnottiana Roxb.

Orchidaceae :
Habenaria rariflora A. Rich.
H. grandiflora Lindle.
H. longicalcarata A. Rich.
H. marginata Coleb.
H. cordifolia A. Rich.

Hypoxidaceae :
Hypoxis aurea Lour.
Curculigo orchioides Gaertn.

Dioscoreaceae :
Dioscorea pentaphylla Linn.
D. oppositifolia Linn.

Liliaceae :
Asparagus racemosus Willd.
Gloriosa superba Linn.
Iphigenia indica A. Gray.
I. pallida Baker.
Scilla indica Baker.
Urginea indica Kunth.
Dipcadi ursulae Blatter.
Chlorophytum laxum R. Br.
C. tuberosum Baker.
C. orchidastrum Lindl.
Aloe vera Linn.

Smilacaceae :
Smilax zeylanica Linn.

Commelinaceae :
Cyanotis tuberosa Schult F.
C. cristata Schult F.
C. axillaris Schult F.
Murdania semiteres Santapau.
(=*Aneilema semiteres* Dalz.)

Araceae :
Arisaema murrayi Hook.
Colocasia esculenta Schott.

Cyperaceae :
Cyperus aristatus Roth.
C. brevifolius Hassk.
C. compressus Linn.
C. corymbosus Rottb.
C. difformis Link.
C. alsinoides Kunth.
C. exaltatus Retz.
C. globosus Allion.
C. iria Linn.
C. michelianus Link.
C. pangori Rottb.
C. pumilus Linn.
C. rotundus Linn.
C. triceps Endl.
Fimbristylis tetragona R. Br.
F. woodrowii C. B. Clarke.
F. dichotoma Vahl.
F. ferruginea Vahl.
F. quinquangularis Kunth.
Eleocharis capitata R. Br.

Gramineae :
Apluda aristata L.
Andropogon pumilis Roxb.
Aristida funiculata Trin.
A. reducta Stapf.
Arthraxon inermis Hook.
A. quartinianus Nash.
A. serrulatus Hoechst.
Arundinella tuberculata Munro.
Bothriochloa pertusa.
Bracharia isachne Stapf.
B. ramosa Stapf.
Chloris barbata SW.
C. virgata Swart.
Chrysopogon montanus Trin.
Cymbopogon martini Stapf.
Cynodon dactylon Pers.
Dactyloctenium aegyptiacum Willd.
Dendrocalamus strictus Nees.
Dicanthium annulatum Stapf.
D. caricosum A. Camus.
Digitaria marginata Link.
D. royleana Prain.
Dimeria ornithopoda Trin.
Dinebra retroflexa Panzer.
Echinochloa colonum Link.
E. crusgalli Beauv.
Eleusine indica Gaertn.
Elyonurus royleanus Nees.
Eragrostis charllis Hitch.
E. ciliansis Link.
E. diarrhena Steud.
E. minor Host.
E. pilosa Beauv.
E. tenuifolia Hochst.
E. uniloides Nees.
Eremopogon foveolatus Stapf.

Eulalia argentea Brongn.
Hackelochloa granularis O. Kuntze.
Heleochloa schoenoides Host.
Heteropogon contortus Beauv.
H. ritchiei Blatter and McC.
H. triticeus Stapf.
Isachne globosa O. Kuntze.
I. pulchella Roth.
Ischemum aristatum Linn.
I. rugosum Salisb.
Iscilema authephoroides Hook.
Lophopogon tridentatus Hack.
Melanocenchrus jacquemontii Jaub.
(=*Gracillea royleana* Hook.)
Microchloa indica Beauv.
Nazia racemosa Kuntze.
Ophiurus exaltatus O. Kuntze.
Oplismensus burmanni P. Beauv.
Oropetium thomaseum Trin.
Panicum maximum Jacq.
P. miliare Lamk.
P. psilopodium Trin.
Paspalidium flavidium A. Camus.
P. punctatum A. Camus.
Paspalum scorbiculatum Linn.
Pennisetum alopeuros Nees.
P. typhoideum Rich.
Sehima nervosum Stapf.
Setaria glauca Beauv.
S. intermedia Haem. and Schult.
S. verticilata Beauv.
Sorghum purpurea-sericium.
S. vulgare Pers.
Sporobolus diander Beauv.
Sporobolus indicus Br.
Thelepogon elegans Roth.
Themeda quadrivalvis O. Kuntze.
Trichotaena wightii Nees.
Tripogon jacquemontii Stapf.
Urochloa halopus Stapf.
Pseudanthistiris heteroclita Hook. f.
Tripogon bromoides Roth.

Pteridophyta :
Ophioglossaceae.
Ophioglossum aitchisoni d'Almeida.

Polypodiaceae :
Actinopteris dichotoma Bedd.
Adiantum capillus-veneris Linn.
A. caudatum Linn.
A. lunulatum Burm.
Cheilanthes albo-marginata Clarke.
Lastrea crenata Bedd.

4·6. Flora at Purandar Fort :

Most of the forts in Desh are on hill crests above 2500′—3000′. They have preserved some original vegetation within their walls. The vegetation outside the walls, especially on the lower slopes was generally destroyed,

during wars in Maratha regime. This was followed by indiscriminate cutting. This is the reason why the hill forts of Torna, Sinhgad, Rajgad, Purandar, Lohgad, Shivaneri, Vishalgad, Panhala etc., look bleak and barren.

Vartak (1953, 1957) has described the flora of Torna, Sinhgad, Rajgad ; Santapau (1947, 1957) of Purandar; Parandekar of Panhala, and of Harishchandragad by B. M. Wadhava etc. (1968). A general account of them is given by Santapau in *Symposium on Deccan Trap Country* (Edited by Mahabale and published by National Academy of Sciences, New Delhi).

Purandar and its twin fort Vazirgad lie 4420′ (1387 m) above M.S.L. and about 2500′ (760 m), respectively above the surrounding plains. Their outer enclosing bastions are 150 m below the top. The N.C.C. Training camp for officers lies above the second enclave and the lower bastions.

The climate of the fort is bracing. The average rainfall is 44″ or 109.4 cm for 15 years (1897-1911). Sometimes, as in 1943, it could be as high as 67.76″ or 172 cm, or could be as low as 40-25″ or 102·8 cm in 1935. Rainfall is maximum in July-August, about 80% of the total.

The temperature at afternoon varies generally from 20.8° C to 35.1°C, rarely as high as 37°.8°C (100°F) in May. December-January are the coldest, temperature reaching 10 C. or 50°F. Winds are not heavy. Weather from October is dry but very dry in summer; in monsoons it is humid. Humidity is never so low as in plains and nourishes the vegetation.

Vegetation : It is dry deciduous in general as will be seen from the list of plants appended below. On the lower slopes of the fort, there are thickets of *karvi* (*Carvia callosa*), thorny bushes of *Euphorbia neriifolia, Lantana camara*, mixed with *Hamiltonia suaveolens*. Since the bushes and small trees on the lower slopes have been mostly cut down, only a few trees have survived. These are *Anogeissus latifolia, Cipadessa fruticosa, Flacourtia indica, Lagerstroemia microcarpa, Dalbergia latifolia, Butea monosperma, Bauhinia racemosa, Bridelia squamosa Heterophragma quadrangulaire* and sparsely distributed *Tectona grandis*, not very tall.

The whole vegetation has the appearance of a dry poor woodland or Savannah, turning into scrub. But the really interesting vegetation in the fort is at higher altitude above 3000′. It is encircled by bushes of *Lasiosiphon eriocephalan, Lobelia nicotianaefolia, Peristrophe bicalyculata, Barleria prionitis*, herbaceous plants of *Senecio grahami, Pimpinella monoica* etc. On the crest of the mountain during monsoons *Thallictrum dalzellii, Impetiens dalzellii, Lepidagathis tricuspidata, Kicknixia ramosissima, Rheinwardia trigona, Oenothera rosea, Artemisia valgaris* are abundant.

In monsoon ephemeral flora of legumes like *Smithia* sps., *Delphinium dasycaulon, Curcuma pseudomontana, Kalanchoe pinnata* appears.

But in addition to these a rare Cactus-like looking world endemic *Frerrea indica* is found in the rocky ledges of Vazirgad. This plant as commented by Dr. T. S. Mahabale is confined to a very few places in the vicinity of Pune. Previously it was known only from Junnar fort, till McCann found its fallen twigs below the steep rocks at Kate's point at Mahabaleshwar. *Ceropegia lawii* is another interesting plant growing above 2000′ but never below 1000′.

Several exotic trees have been planted inside the fort and on the higher plateaux e.g. *Casuarina equisetifolia, Delonix regia, Celastrus glomeratus, Veronica angellis.* Some of the plants are escaped from the garden, and are of European origin. The list below does not include these, nor the commonplace ones. It gives only important plants from Santapau's list.

Monsoon ephemeral plants are also the same as elsewhere, where rainfall is not heavy as in Lonavala. They disappear by November but are highly picturesque in monsoon after August. In the dry streams at the base of the fort *Ophiolgossum reticulatum* grows. On lower slopes *O. gramineum* is also found. The water tanks in Vazirgad abound in *Volvox* and liverworts on rocks

Important Plants from Flora of Purandar after Santapau (1947)

Ranunculaceae :
Clematis triloba Heyne ex Roth.
Clematis gouriana Roxb.
Clematis hedysarifolia DC.
Delphinium dasycaulon Fres.
Thalictrum dalzellii Hook.

Magnoliaceae :
Michelia champaca Linn.

Menispermaceae :
Cocculus hirsutus (Linn.) Diels.
Cocculus pendulus Diels.

Cruciferae :
Rorippa indica (Linn.) Hoechreut.
Cardamine trichocarpa Hoechst.

Capparidaceae :
Cleome simplicifolia (Camb.) Hook f. and Thoms.
Gynandropsis gynandra (Linn.) Briq.

Flacourtiaceae :
Flacourtia indica Merr.

Polygalaceae :
Polygala persicariaefolia DC.
Polygala chinensis Linn.

Caryophyllaceae :
Saponaria raccaria Linn.
Cerastium glomeratum Thuill.
Polycarpaea corymbosa Lamk.

Portulacaceae :
Talinum cuneifolium Willd.

Malvaceae :
Kydia calycina Roxb.
Sida rhombifollia Linn.
Abutilon polyandrum (Roxb.) Wt. and Arn.
Hibiscus trigonum Linn.
Hibiscus solandra L'Herit.
Abelmoschus manihot (Linn.) Medik.

Bombacaceae :
Salmalia malabarica (DC.) Schott. and Endl.

Sterculiaceae :
Eriolaena quinquelocularis Wight.

Tiliaceae :
Grewia tilaefolia Vahl.
Triumfetta rotundifolia Limk.
Corchorus trilocularis Linn.

Linaceae :
Linum mysorense Heyne.
Reinwardtia trigyna (Roxb.) Planch.

Malpighiaceae :
Hiptage bengalensis (Linn.) Kurz.
Aspidopteris cordata (Heyne) A. Juss.

Geraniaceae :
Geranium ocellatum Camb. var. *himalaicum* (Kunth) Engler

Oxalidaceae :
Biophytum sensitivum (Linn.) DC.

Balsaminaceae :
Impatiens balsamina Linn. var. *rosea* Hook f.
Impatiens dalzellii Hook. f. and Thoms.
Impatiens oppositifolia Linn.
Impatiens Sp.

Burseraceae :
Garuga pinnata Roxb.

Meliaceae :
Soymida febrifuga (Roxb.) A. Juss.
Toona ciliata Roem.

Celastraceae :
Celastrus paniculata Willd.
Gymnosporia spinosa Fiori.

Rhamanaceae :
Zizyphus glaberrima Santapau.
Zizyphus rugosa Lamk.
Rhamnus triquester (Wall.) Laws.
Colubrina asiatica (Linn.) Brogn.

Vitaceae :
Cissus woodrowii Santapau.
Cissus elongata Roxb.
Cissus repanda Vahl.
Leea robusta Roxb. Hort. Beng.
Leea edgeworthii Santapau.

Papilionaceae :
Heylandica latebrosa DC.
Crotalaria filipes Benth.
Crotalaria filipes var. *trichophora* Cooke.
Crotalaria calycina Schrad.
Crotalaria medicaginea Lamk.
Crotalaria orixensis Willd.

Indigofera glandulosa Willd.
Indigofera hendecaphylla Jacq.
Indigofera tinctoria Linn.
Psoralea corylifolia Linn.
Sesbania sesban var. *picta* Santapau.
Smithia conferta Sm.
Smithia setulosa Dalz.
Smithia bigemina Dalz.
Alysicarpus tetragonolobus Edgq.
Alysicarpus vaginalis (Linn.) DC.
Alysicarpus belgaumensis WT.
Alysicarpus belgaumensis var. *racemosus* Baker.
Desmodium triflorum (Linn.) DC.
Desmodium parviflorum (Dalz.) Baker.
Teramnus labialis (Linn. f.) Spreng.
Mucuna prurita Hook.
Butea monosperma (Lamk.) Taubert.
Canavalia glandiata (Jacq.) DC.
Phaseolus khandalensis Santapau.
Phaseolus aconitifolus Jacq.
Phaseolus dalzellii Cooke.
Dolichos bracteatus Baker (in Hook f. FL Brit.)
Atylosia sericea Benth.
Atylosia scarabaeoides (Linn.) Benth.
Rhynchosia minima (Linn.) DC.
Cylista scariosa Roxb.
Moghania strobilifera (Linn.) St. Hil
Dalbergia latifolia Roxb.
Dalbergia lanceolaris Linn. f.
Pongamina pinnata (Linn.) Pierre

Caesalpiniaceae :
Caesalpinia sappan Linn.
Cassia fistula Linn.
Cassia sophera Linn.
Bauhinia purpurea Linn.
Bauhinia racemosa Lamk.
Sonchus asper (Linn.) Hill.
Sonchus arvensis Linn.
Lannaea nudicaulis Hook. f.
Cichorium intybus Linn.

Lobeliaceae :
Lobelia heyneana Roem. et Schult.

Campanulaceae :
Campanula alphonsii Wall. ex. DC.
Campanula canescens Wall. ex. DC.
Campanula ramulosa Wall. ex. Roxb.

Plumbaginaceae :
Plumbago zeylanica Linn.

Sapotaceae :
Mimusops elengi Linn.

Ebenaceae :
Diospyros montana Roxb.

Oleaceae :
Nyctanthes arbor-tristis Linn.

Apocynaceae :
Carissa congesta Wt.
Lochnera rosea (Linn.) Reich.
Wrightia tinctoria R. Br.

Asclepidaceae :
Hemidensmus indicus (Linn.) R. Br.
Cryptolepis buchanani Roem. Scultz.
Cyanchum callialata Ham.
Gymnema sylvestris (Retz.) R. Br.
Tylophora dalzellii Hook. f.
Pergularia daemia (Forsk.) et. MeC.
Marsdenia volubilis Cooke.
Ceropegia lawii Hook. f.
Ceropegia evansii McCann.
Ceropegia aculeata Hook.
Frerrea indica Dalz.

Loganiaceae :
Budellia asiatica Lour.

Gentianaceae :
Exacum pedunculatum Linn.
Exacum pumilum Griseb.
Exacum lawii Clarke
Centaurium roxburghii (Don) Druce.
Canscora diffusa R. Br.
Canscora pauciflora Dalz.
Swertia minor Forst. f.

Boraginaceae :
Cynoglossum wallichii G. Don, Gen. Syst.
Adelocaryum coelestinum (Lindl.) Brand.

Convolvulaceae :
Porana malabarica Clarke.
Evolvulus alsinoides Linn.
Convolvulus arvensis Linn.
Ipomoea ericcarpa R. Br. Prodr.
Ipomoea nil (Linn.) Roth
Argyreia setosa (Roxb.) Choisy.

Solanaceae :
Solanum indicum Linn.

Scrophulariaceae :
Kickxia ramosissima (Wall.) Janchen.
Kickxia incana (Wall.) Pennell.
Dopatrium junceum (Roxb.) Buch. Ham.
Lindernia parviflora (Roxb.) Haines.
Lindernia sessiliflora (Benth.) Wettst.
Sutera dissecta Walp, Santapau.
Stemodia viscosa Roxb.
Buchnera bispida Buch. Ham.
Striga gesneroides (Willd.) Vatke.
Striga densiflora Benth.

Mimosaceae :
Leucaena glauca (Linn.) Benth.
Mimosa pudica Linn.
Mimosa hamata Willd.

Acacia arabica Willd.
Acacia farnesiana Willd.
Acacia tomentosa Willd.
Acacia torta Graib.
Acacia pennata (Linn.) Willd.

Crassulaceae :
Kalanchoe olivacea Dalz.

Combretaceae :
Terminalia crenulata Roth.
Terminalia chebula Retz.

Myrtaceae :
Syzygium cumini (Linn.) Skeels.

Lythraceae :
Rotala densiflora (Roth) Koehne.
Rotala tenuis (W.T.) Koehne.
Ammannia multiflora Roxb.
Ammannia baccifera Linn.
Woodfordia fruticosa (Linn.) Kurz.

Onagraceae :
Oenothera rosea Ait.

Cucurbitaceae :
Melothria maderaspatana (Linn.) Cogn.
Dicoelospermum ritchiei Clarke.

Molluginaceae :
Glinus lotoides Linn.

Apiaceae :
Centella asiatica (Linn.) Urb.
Trachispermum stictocarpum Wolff var. *typicum* Wolff.
Pimpinella tomentosa Dalz.
Pimpinella monoica Dalz.
Heracleum concanense Dalz.

Rubiaceae :
Pavetta indica Linn.
Hamiltonia suaveolens Roxb.
Borreria stricta (Linn. f.) Schum.
Rubia cordifolia Linn.

Compositae :
Centratherum tenue (Wt.) Clarke.
Centratherum hookeri Clarke.
Vernonia cinerea (Linn.) Less.
Vernonia divergens (Roxb.) Edgew.
Ageratum conyzoides Linn.
Cyathocline purpurea (Don) O. Kuntze.
Conyza viscidula Wall. Ex DC.
Blumea eriantha DC.
Blumea lacera DC.
Blumea malcolmii (Clarke) Hook. f.
Blumea membranacea DC.
Blumea oxyodonta DC.
Blumea mollis (Don) Merr.
Pluchea tomentosa DC.
Sphaeranthus indicus Linn.
Gnaphalium luteo-album Linn.

Gnaphalium pulvinatum Del.
Siegesbeckia orientalis Linn.
Blainvillea latifolia (Linn. f.) DC.
Artemisia parviflora Buch. Ham.
Artemisia nilgirica (Clarke) Pamp.
Gynura angulosa DC.
Notonia grandiflora DC.
Senecio hiwrensis (Dalz.) Hook. f.
Senecio edgworthii Hook. f.
Senecio grahami Hook. f.
Senecio belgaumensis (Wt.) Clarke.
Senecio gibsoni Hook. f.
Volutarella ramosa (Roxb.) Santapau.
Sonchus oleraceus Linn.
Rhamphicarpa longiflora (Arn.) Benth.
Sopubia trifida Buch. Ham.
Lindenbergia indica (Linn.) O. Kuntze.

Orobanchaceae :
Christisonia lawii Wt. on *Carvia callosa*.

Lentibulariaceae :
Utricularia striatula Sm.

Bignoniaceae :
Heterophragma quadriloculare (Roxb.) Schum.

Acahthaceae :
Hemigraphis latebrosa Nees var. *heyneana* Bremek.
Dyschoriste dalzellii (Anders) O. Kuntze.
Eranthemum roseum (Vahl) R. Br.
Carvia callosa (Wall.) Bremek.
Thelepaepale ixiocephala (Benth.) Bremek.
Andrographis echioides (Linn.) Nees.
Haplanthus verticillatus (Roxb.) Nees.
Barleria prionitis Linn.
Asystasia dalzelliana Santapau.
Lepidagathis mitis Dalz.
Lepidagathis cuspidata (Wall.) Nees.
Rungia pectinata (Linn.) Nees.
Dicliptera micranthes Nees.
Dicliptera zeylanica Nees.
Justicia betonica Linn.
Justicia diffusa Willd.
Justicia quinqueangularis Koen.
Justicia simplex D. Don.
Justicia micrantha Heyne.
Adhatoda vasica Nees
Rhinacanthus nasuta (Linn.) Kurz.
Peristrophe bicalyculata (Retz.) Nees.

Verbenaceae :
Lantana camara Linn. var. *aculeata* (Linn.) Mold.
Tectona grandis Linn. f.
Phyla nodiflora (Linn.) Green.

Lamiaceae (LABIATAE) :
Ocimum americanum Linn.
Plectranthus costata Bach-Ham.
Plectranthus mollis (Ait.) Spreng.

Plectranthus stocksii Hook. f.
Coleus forskohlii (Poir.) Briq.
Anisochilus carnosus (Linn.) Wall.
Anisochilus verticillatus Hook. f.
Lavandula perrottetii Benth.
Lavandula bipinnata var. *rothiana* O. Kuntze
Pogostemon plectranthoides Desf.
Pogostemon parviflorus Benth.
Colebrookea oppositifolia Smith.
Anisomeles malabarica R. Br.
Anisomeles heyneana Benth.
Leucas stelligera Wall.
Leucas lavandulaefolia Nees.
Leucas biflora R. Br.
Leucas montana Spreng.
Nepeta hindustana Haines var. *woodrowii* (Cooke) Santapau.

Nyctaginaceae :
Boerhaavia repanda Willd.

Amarantaceae :
Aerua sanguinolenta (Linn.) Blume.

Polygonaceae :
Polygonum plebjeum R. Br.
Polygonum glabrum Willd.
Polygonum nepalense Meisn.

Piperaceae :
Peperomia pellucida (Linn.) H. B. K.

Proteaceae :
Grevillea robusta A. Cunn. (Planted)

Thymeleaceae :
Lasiosiphon eriocephalus Decne.

Loranthaceae :
Dendrophthoe falcata (Linn. f.) Etting.
Scurrula philippinensis (Cham. et. Schl.) D. Don.
Taxillus cuneatus (Roth) Danser.

Santalaceae :
Osyris wightiana Wall.

Euphorbiaceae :
Euphorbia fusiformis Buch. Ham.
Bridelia squamosa Gehrm.
Emblica officinalis Gaertn.
Phyllanthus maderaspatensis Linn.
Securinega virosa (Oxb.) Pax et Hoffm.
Mallotus philippinesis Mull. Arg.
Acalypha malabarica Muell. Arg.

Urticaceae :
Urficaceae.
Trema orientalis (Linn.) Blume.
Fleurya interrupta (Linn.) Gaud.
Girardinia zeylanica Decne.

Moraceae :
Ficus nervosa Heyne.
Ficus heterophylla Linn. f.
Ficus arnottiana Miq.
Ficus arnottiana var. *courtallensis* King.

Orchidaceae :
Dendrobium microbulbon Rich.
Dendrobium mabelae Gammie.
Dendrobium barbatulum Lindl.
Eulophia ochreata Lindl.
Aerides maculosum Lindl.
Peristylus stocksii (Hook. f.) Kranz.
Habenaria hollandiana Santapau.
Habenaria crassifolia Rich.
Habenaria digitata Lindl.
Habenaria gibsoni Hook. f.
Habenaria grandiflora Lindl.
Habenaria grandifloriformis Blatt. et McCann.
Habenaria heyneana Lindl.
Habenaria longicalcarata Rich.
Habenaria marginata Coleb.
Habenaria rariflora Rich.
Bervilia aragoana Gand.

Zingiberaceae :
Hitchenia caulina (Graham) Baker.
Curcuma pseudomontana Graham.
Zingiber macrostachyum Dalz.

Musaceae :
Ensete superbum (Roxb.) Cheesm.

Hypoxidaceae :
Hypoxis aurea Lour.
Curculigo orchioides Gaertn.

Amaryllidaceae :
Pancratium parvum Dalz.
Pancratium Sp.

Dioscoreaceae :
Dioscorea pentaphylla Linn.
Dioscorea bulbifera Linn.

Liliaceae :
Asparagus racemousus var. *javanica* Baker.
Gloriosa superba Linn.
Iphigenia pallida Baker.
Scilla hyacinthina (Roth) MacBride.
Urginea indica (Roxb.) Kunth.
Chlorophytum tuberosum (Roxb.) Baker.
Aloe variegata Linn.

Commelinaceae :
Murdannia semiteres Santapau.
Cyanotis tuberosa (Roxb.) Schult. f.
Cyanotis fasciculata Schult. f.
Cyanotis cristata (Linn.) Schult.
Cyanotis axillaris (Linn.) Schult. f.

Araceae :
Arisaema murrayi (Grah.) Hook.
Arisaema neglectum Schott.
Arisaema tortuosum (Wall.) Schott.
Sauromatum guttatum (Wall.) Schott.

Eriocaulaceae :
Eriocaulon nepalense Presc.

4.7: *Flora of Khandala :*

Khandala is a well-known hill station on the Central Railway, 116 km. from Bombay and 66 km. from Pune. It stands at an elevation of 677 m. above the mean sea level and 630 m. above Konkan plains to the West. The northern portion, Kune plateau, is above the St. Mary's stream and ravine, but the highest part at Khandala is the Bhoma Hills, 2781′ or 848 m. above the sea level. The Echo point is a little below, 722 m. high. The Duke's Nose is a well-known feature of a massive hill. To the north of Khandala lies the Behram plateau. It ends abruptly on all sides. In the distant geological times this plateau was continuous with that of Matheran 18 km. away to N-NW, connected with the main Deccan plateau. The tops of both are nearly at the same height and have similar flora. St. Xavier's Ravine runs S to SW direction 3 km. long, and then goes into the valley below Rajmachi Hill.

Climate : Khandala being at the edge of the Ghats, gets maximum rainfall. It begins towards the end of May or beginning of June and lasts till early September with occasional breaks in August. Winds run NW-SE. The return monsoon is not very significant. The rainfall is so heavy that it could be 335 mm in a day some times. Total rainfall for 1952 was very low 90″ or 228.60 cm. Average for 16 years is 193″ approx. Due to torential rains, the top soil in many parts of Khandala is completely washed off and hence the vegetation gets deforested. Only low grade cereals like *Eleusine coracana* or *Nachni* grow here. Due to washing away the soil, rocks get denuded and lie bare open. The number of rainy days varies from 96 to 112. Winds in monsoon blow 60 km. per hour SW-NE. In other seasons they are not so strong and blow N-NE. The relative humidity is 90 per cent in early mornings even in the driest months. It is reduced to 70 per cent in hot season and to 25 per cent in afternoon. The maximum temperature is 37°.8 C or 100°F in summer in April-May, which are the hottest months and 21°.1C or 70°F in early rainy days. The lowest temperature is generally in December-January, 14°.5C.

Soils : The hills being volcanic in origin, soils are derived from basalt. They are under the influence of heavy rains, which do not allow them to mature. At Bhoma Hills, Echo Point, Behram plateau they are red to deep black cotton soils but nowhere they are similar. In other places they are of intermediate colour.

Many renowned botanists had explored this place botanically since long. Among them may be mentioned John Graham (1805—1839), Blatter and Hallberg, McCann, Santapau (1947). A number of distinguished botanists are mentioned by Cooke (1901—1908) in his introduction to his *Flora of the Bombay Presidency*, who have collected plants at Lonavala and Khandala. Notable among them are Law, Stocks, Woodrow, Cooke himself, Sedgewick, Bhide, Bhiva, Kanitkar, McCann, etc.

Vegetation : Evergreen Forests : At Behram plains in the Bor Ghat, there are no deciduous trees except on the top of that plain. The habit of shedding leaves is not uniform due to high humidity throughout the year. There are also several evergreen trees, although some of them shed their leaves in the rainy season. The top layer canopy at Meroli Plateau consists of *Caryota urens, Ficus nervosa, F. racemosa, Schleichera cleosa, Madhuca indica, Tetrameles nudiflora, Dysoxylon binectariferum, Alstonia scholaris, Albizzia procera, Holigarna grahami,* mixed with *Entada pursaetha, Combretum ovalifolium, Diploclisiaglaucesens, Calycopteris floribunda.* On the edges of the Meroli Plateau, away from the Ravine, some well-developed large trees of *Garcinia talboti, Lepi santhes tetraphylla, Lagerstroemia lanceolata* are found mixed with climbers like *Anodendron paniculatum, Symphorema involucratum.*

The second layer has *Hymenodictyon obovatum, Gmelina arborea, Sterculia guttata, Erinocarpus nimmonii, Mammea surirega, Syzygium cumini, Miliusa tomentosa* and shrubs of *Glycosmis mauritiana, Carissa congesta,* followed by broad-leaved grasses like *Oplismenus compositus,Piper nigrum,* and *Gnetum ula.* There is not much of green vegetation due to soil erosion, but on the rocks and tree trunks, and in the crevices of slopes where soil has been preserved, monsoon ephemerals of *Impatiens,* members of Zingiberaceae, *Costus speciosus* appear. The important places for collection at Khandala are : (1) Meroli Plateau, (2) Bhoma Hills, (3) River, (4) St. Xavier's Ravine, (5) Kune Plateau, (6) Elphinstone slopes, (7) Old Khandala Road and Rai Wood or Devrai near Lonavala station on old Khandala Road.

Other important localities are (1) St. Xavier's Ravine, (2) Duke's Nose Ravine. Here the vegetation is similar to that of Meroli Plateau but the trees are not massive. The moist deciduous plants like *Bombax insigne, Mimusops elengi* get mixed up with *Sageraea laurifolia, Terminalia chebula* and bushes of *Haplanthus verticillatus, Neuracanthus trinervius.* Woody lianas like *Bauhinia vahlii, Butea superba* (*Butea parviflora*), *Gnetum ula, Strychnos colubrina, Anodendron paniculatum* and woody species of Ampelidaceae (Vitaceae), climbers like *Capparis moonii, Elaeagnus conferta* are seen and large stands of *Strobilanthes callosus, S. ixiocephalus, S. perfoliatus* are very common. On the open slopes of ravine *Ensete superbum* is noticeable, often growing in precarious positions. The vegetation is of semi-evergreen type and uniform . At the bottom of the ravine along the stream *Bambusa arundinacea* is abundant.

The third important locality for plants is Bhoma Hills. On its top, plants like *Terminalia chebula, T. bellerica, T. crenulata, Bridelia squamosa, Crotalaria retusa, Glochidion hohenackeri, Sterculia guttata, Diospyros montana, Actinodaphne angustifolia, Bombax insigne, Dillenia pentagyna, Celastrus paniculata* dominate the scenery. *Lobelia nicotianaefolia, Kydia calycina, Pittospermum floribundum, Walsura trijuga, Cordia obliqua Rauvolfia densiflora* are also found but are rare. Among the climbers *Smilax zeylanica, Entada pursaetha, Olax wightiana, Clematis hedysarifolia* are noteworthy. *Vitex negundo, Lantana camara, Stachytarpheta jamaicensis* appear to have been naturalized. *Asclepias curasavica* has spread up to *Fourbay. Carvia callosa, Euphorbia neriifolia* form undergrowth on Behram plateau. There are many evergreen species such as *Sapium insigne* var. *malabaricum, Ixora brachiata, Hymenodictyon obovatum, Careya arborea, Cassia fistula, Sterculia guttata, Asparagus racemosus* var. *javanicus, Smilax zeylanica, Ventilago*

madaraspatana etc. The vegetation appears to be transitional and presents different aspects. It changes according to seasons. In summer they look dry, but towards the end of rainy season and each winter it gets changed due to large plants of *Senecio grahami, Neuracanthus sphaerostachys, Dysophylla stellata.* In marshy places *Hygrophila serpyllum* var. *hookeriana, Utricularia* sp., *Striga gesneroides* var. *minor Blumea oxyodonta* are seen sometimes ; but with approaching summer season, most of these plants and grass die, and only the trees of *Terminalia crenulata, Memecylon umbellatum* flower, or they may be without flowers. Trees of *Terminalia crenulata* get fully covered with orchids like *Dendrobium barbatulum, Eria dalzelli, Aerides crispum.*

On Kune and Khandala plateaus several plants of *Peltophorum feruginosum, Pterocarpus marsupium, Delonix regia* etc. are cultivated. Garden plants such as *Syzygium jambos* are introduced and grow side by side with naturally growing *Cassia fistula, Firmiania colorata, Opuntia etator.*

There is a rich herbaceous vegetation also, composed of *Salvia plebeia, Colebrookea oppositifolia, Pogostemon bengalense, Leucas stelligera.* They are transitional climax of seasonal vegetation here.

On the Elphinstone Road below the Elphinstone Point one sees *Atlantia racemosa,* so common at Bhimashankar and on Junnar Hills. *Putranjiva roxbourghii, Tetrameles nudiflora, Ventilago bombaiensis* form rich semi-evergreen vegetation if left undisturbed. They all resemble the vegetation at Meroli Plateau, but as we come towards Lonavala, they get mixed with drier species.

Monsoon Ephemerals : The most remarkable feature of the vegetation at Khandala and Lonavala are the monsoon ephemerals. They begin to appear soon after the first rains and come to high pitch from August to October. Soon after rains *Pancratium* sp., *Curculigo orchioides, Curcuma pseudomontana, Arisaema murrayi* appear ; but the most spectacular are *Impatiens kleineii, Hypoxis aurea, Cissus elongata, Tylophora fasciculata, Fimbristylis digitata, Ensete superbum.* New grasses begin to appear within about 10 days after rains. *Cyperus rotundus, Exacum pumilum, Ceropegia attenuata ; Impatiens balsamina* grow fast with *Chlorophytum glaucum, C. tuberosum, Begonia crenata, Barleria prattensis.* Six species of ground chids *Habenaria, Orchids H.rariflora, H. ordigitata, H. heyneana, H. grandiflora, H. longicorniculata, H. marginata, Platanthera sussanae* add beauty to land scape. In the middle of the rainy season several Compositae, herbaceous Rubiaceae like *Anotis foetida, Drosera indica, Spermacoce cinearis, Smithia sensitiva, Elephantopus scaber, Cyanotis tuberosum, Senecio grahami, Clerodendron sub-serratum, Geissospis eristata* appear in large numbers. In isolated corners *Oroxylum indicum, Begonia concanensis, Exacum bicolor, Kaemphera scaposa, Rhynchoglossum oblongum* var. *parviflorum, Sonerila seapigera, Impatiens acaulis, Ceropegia evansli, Leea robusta, L. setuligera* appear prominent. It is a remarkable sight to watch these monsoon ephemerals grow and bloom gregariously. They completely disappear soon after the onset of winter.

On the whole, the vegetation in the ravines and on the sunny slopes is of the evergreen or semi-evergreen type, and places where water gets retained, it is of the moist deciduous type slowly changing to transitional vegetation which is a mixture of moist and dry species. The monsoon ephemeral flora at Lonavala and Khandala is very remarkable and lasts

till October end. Many tuberous and rhizomatous plants are seen during rainy season and last throughout by underground parts, but their aerial parts all disappear in summer. The monsoon ephemeral flora on the hill tops contains both temperate herbaceous plants and recently arrived grasses, Compositae, herbaceous Begoniaceae and Rubiaceae. There are a large number of cultivated plants, both trees and shrubs, and herbs at Khandala and Lonavala introduced by foreigners who used to stay here, and by the members of the St. Xavier's Villa.

There is also a remarkable group of evergreen trees like *Holigarns grahami* and climbers like *Entada pursaetha*, *Gnetum ula* in a place like Deorai wood near Lonavala station. They are relict types.

Vegetation of Khandala tends to become woodland savannah towards Talegaon and merges with open grasslands.

The following are some of the important plants found at Khandala :

1. Several species of ground and epiphytic orchids.
2. *Drosera indica* a small insectivorous plant on Sakharpathar.
3. *Hymenodictyon excelsum*, *Actinodaphne hookeri*, *Bixa orellena*.
4. Aqueous plants *Hygrorhliza aristata Dysophylla stellata*, *Blysa* found in Khandala lake.
5. Climbers *Entada pursaetha*, *Gnetum ula*, *Eraeodendron glaucum* are huge lianas not to be seen elsewhere.
6. Several species of Balsams, ferns both on the ground and on tress epiphytic *Lycopodium hamiltoni* growing at great heights on tall trees in Rai wood, several mosses ; *Psilotum nudum* growing epiphytically ; *Isoetes coromandelina* ; *Ophioglossum fibrosum* and *O. nudicaule*, *O. gramineum* and several species of liverworts and fungi are found here.

A considerable part of vegetation of Khandala is destroyed by man and even by hundreds of students and botanists visiting the place. They collect common and rare plants by gunny bags and throw away afterwards. This is the most destructive practice from the point of vegetation. The more important plants enlisted above will show how rich is the vegetation here. For further details see Santapau's *Flora of Khandala*, (1947).

List of Selected Important Plants of Khandala And Lonawala
(after Santapau, 1947).

DICOTYLEDONS—

Ranunculaceae :
Clematis gouriana Roxb. ex DC.
C. hedysarifolia DC.
Delphinium dasycaulon Fres. Mus. Senckenb.

Dilleniaceae :
Dillenia pentagyna Roxb.

Anonaceae :
Miliusa tomentosa Roxb.
Sageraea laurifolia (Grah.) Blatter.

Menispermaceae :
Diploclista glaucescens Blume
Stephania japonica Thumb.

Cocculus hirsutus Linn.
Cissampelos pereira Linn.
Cyclea burmanni DC.

Cruciferae (Brassicaceae):
Cardaminne trichocarpa Hoechest.

Capparidaceae :
C. separia Linn.
Capparis moonii Wight
C. zeylanica Linn.

Flacourtiaceae :
Flacourtia montana Graham.
F. indica Burm. f.

Pittosporaceae :
Pittosporum floribundum Wight

Caryophyllaceae :
Vaccaria pyramidata Medik.

Elatinaceae :
Burgia ammanioides Roxb. ex Roth

Gutiferae :
Garcinia indica (Du Pett) Thom.
G. spicata (Wight and Arn.) Hook. f.
G. talboti Raizada ex Santapau
Mammea suriga (Buch-Ham. ex. Roxb.) Koester.

Malvaceae :
Sida rhombifolia Linn. var. *retusa* Masters
S. rhombifolia Linn. var. *rhomboidea* Masters
Kydia calycina Roxb.
Abutilon polyandrum Schlecht.
Urena lobata Linn.
Abelmoschus manihot Linn.
A. esculentus Linn.
Azanza lampas Cav.

Bombacaceae :
Bombax ceiba Linn.
B. insigne Wall.

Sterculiaceae :
Sterculia urens Roxb.
S. villosa Roxb.
S. guttata Roxb.
Firmiana colorata R. Br.
Pterospermum acerifolium Willd.

Elaeocarpaceae :
Elaeocarpus sphaericus (Garetn.) Schumann

Linaceae :
Reinwardtia trigyna (Roxb.) Planch.

Malphigiaceae :
Hiptage benghalensis (Linn.) Kurz
Aspidopterys indica (Roxb.) Hoechest
A. cordata (Heyne) A. Juss.

Balsaminaceae :
Impatiens acaulis Arn.
I. oppositifolia Linn.
I. kleinii Wight & Arn.
I. kalsamina Linn.
I. balsamina Linn. var. *rosea* Hook. f.
I. balsamina Linn. var. *corymbosa* Santapau

Rutaceae :
Evodia lunulatum (Gaertn.) Merrill.
Fagara budrunga Roxb.
Toddalia asiatica (Linn.) Lamk.
Glycosmis mauritiana (Lamk.) Tanaka.
Murraya koenigii (Linn.) Spreng.
Atalantia monophylla (Roxb.) DC.
A. racemosa Wight and Arn.

Burseraceae :
Garuga pinnata Roxb.

Meliaceae :
Turraea villosa Benth.
Disoxylon binectariferum (Roxb.)
Amoora lawii (Wight ex Bedd.) Hook. f.
Walsura trijuga (Roxb.) Kurz.
Olax wightiana Wall. ex. Wight and Arn.

Opiliaceae :
Cansjera rheedii Gmel.

Icacinaceae :
Nothopodytes foetida (Wt.) Sleumer

Hippocrateaceae :
Reissantia arahamii (Wt.) Ding Hou
Salacia prinoides DC.

Celastraceae :
Celastrus paniculata Willd.
Gymnosporia rothiana Wight and Arn.
Elaeodendron roxburghii Wight. and Arn.

Rhamnaceae :
Ventilago bombaiensis Dalx.
V. madaspatna Gaertn. var. *ructiflida* Santapau
Zizyphus horridra Roth.
Z. glaberrima Santapau
Scutia circumcissa (Linn. f.) Druce

Vitaceae :
Ameocissus latifolia (Roxb.) Planch.
Cissus discolor Blume
Cissus repanda Vahl.
C. woodrowii (Stapf) Santapau
Tetrastigma canarense (Dalz.) Gamble
Leea robusta Roxb.
L. indica (Brum.) Merrill
L. setuligera Clarke

Anacardiaceae :
Iannea coromandelica (Houch.) Merrill
Holigarna grahami (Wight) Hook. f.
Semecarpus anacardium Linn.

Papilionaceae :
Heylandia latibrosa DC.
Crotalaria mysorensis Roth.
C. triquetra Dalz.
C. albida Heyne ex Roth.
C. nana Burm.
C. retusa Linn.
Melilotus indica All.
Tephrosia tinctoria Pers.
T. canarensis J. R. Drumnond
Sesbania bispinosa (Jacq.) Fawcett and Rendle
Geissaspis cristata Wight and Arn.
G. tenella Benth.
Simithia sensitiva var. *flava* (Dalx.) Cooke
S. conferta Sm.
S. purpurea Hook.
S. setulosa Dalz.
Alysicarpus vaginalis
A. glumaceus (Vahl.) DC.
A. belgaumensis Wight
Desmodium laxiflorum DC.
D. gangeticum (Linn.) DC.
D. rotundifolium Baker
D. alysicarpoides Knapp van Meeuwen
Teramnus labialis (Linn. f.) Spreng.
Mucuna prurita Hook.
Erythrina stricta Roxb.
Butea parviflora Roxb.
B. monosperma (Lamk.) Taub.
B. monosperma var. *lutea* Mahesh.
B. superba Roxb.
Canavalia stocksii Dalz.
Pueraria tuberosa (Roxb.) DC.
Phaseolus khandalensis Santapau
P. dalzellii Cooke
Vigna capensis Walp.
Dolichos falcatus Klein ex Willd.
Atylosia sericea Benth.
A. lineata Wight and Arn.
Cylista acariosa Roxb.
Moghania strobilifera Linn.
M. gracilis Mukerjee
Dalbergia latifolia Roxb.
D. sympathetica Nimmo ex Graham
Derris scandens (Roxb.) Benth.

Caesalpinaceae :
Cassia fistula Linn.
C. absus Linn.
Bauhinia racemosa Lamk.
B. malabarica Roxb.
B. vahlii Wight and Arn.
B. purpurea Linn.

Mimosaceae :
Entada pursaetha DC.
Acacia torta (Roxb.) Craib

Rosaceae :
Pygeum gardneri Hook. f.

Droseraceae :
Drosera indica Linn.

Haloragaceae :
Myriophyllum spathulatum Blatt. and Hallb.

Rhizophoraceae :
Carallia brachiata (Lour.) Merrill

Combretaceae :
Terminalia bellerica (Gaertn.) Roxb.
T. chebula Retz.
T. crenulata Roth.
Calycopteris floribunda (Roxb.)
Anogeissus latifolia (Bedd.) Lamk.
Combretum ovalifolium Roxb.
C. latifolium Blume

Myrtaceae :
Syzygium cumini (Linn.) Skeels

Lecythidaceae :
Careya arborea Roxb.

Melastomaceae :
Osbeckia truncata Don
Sonerila scapigera Hook.
Memecylon umbellatum Burm.
M. umbellatum var. *capitellatum* Cooke
M. talbotianum Brandis

Lythraceae :
Ammania multiflora Roxb.
A. baccifera Linn.
A. senegalensis Lamk.
Rotala indica (Willd.) Kochne
R. serpyllifolia (Roth) Bremek.
Woodfordia fruticosa (Linn.) Kurz.
Lagerstroemia parviflora Roxb.
L. lanceolata Wall. ex Wight and Arn.

Onagraceae :
Ludwigia octovalvis Subsp. *sessiliflora* (Micheli) Raven

Samydaceae :
Casearia graveolens Dalx.

Begoniaceae :
Begonia crenata Dryad
B. concanensis DC.

Tetramelaceae :
Tetrameles nudiflora R. Br.

Apiaceae :
Centella asiatica (Linn.) Urban.
Pimpinella heyneana Wall.
P. adscendes Dalz.
P. multiradiata Santapau
Heracleum sprengelianum Wight and Arn.
H. concanense Dalz.

Rubiaceae :
Adina cordifolia (Roxb.) Hook f.
Mitragyna parviflora (Roxb.) Korth.
Hymenodictyou excelsum (Roxb.) Wall.
H. obovatum Wall.
Wendlandia heynei (R. and S.) Santapau and Merchant
Oldenlandia corymbosa Linn.
O. maheshwarii Santapau and Merchant
Anotis lancifolia (Dalz.) Hook f.
Mussaenda glabrata (Hook. f.) Hutch.
Xeromphis spinosa (Thumb.) Keay.
Gardenia resinifera Roth.
Ixora arborea Roxb. ex Sm.
I. nigricans R. Br. ex Wight and Arn.
Pavetta concanica Bremek.
P. crassicaulis Dremek.
P. tomentosa Roxb. ex Rees.
Sepermadictyon suaveolens Roxb.
Borreria stricta (Linn. f.) Schum.

Asteraceae :
Centratherum phyllotaenum (D. C.) Benth ex Clarke
C. tenue (Wight) Clarke
Vernonia cinerea (Linn.) Less
V. divergens (Roxb) Edg.
Elephantopus scaber Linn.
Blumea mollis (Don) Merrill
B. membrenacea DC.
B. belangeriana DC.
B. malcolmii
Artemesia parviflora Buch. Ham. ex Roxb.
A. nilagirica (Clarke) Pamp
Gynura cusimbua Moore
Notonia grandiflora DC.
Senecio dalzellii Clarke
S. grahami Hook. f.
Tricholepis amplexicaulis Clarke

Lobeliaceae :
Lobelia nicotinaefolia Heyne
L. heyneana Roem and Sch.
L. alsinoides Lamk.

Campanulaceae :
Vahlenbergia marginata (Thunb.)

Plumbaginaceae :
Plumbago zeylanica Linn.

Myrisinaceae :
Embelia Tsjeriam-Cottam A. DC.

Sapotaceae :
Madhuca indica Gmel.

Ebenaceae :
Diospyros montana Roxb.
D. sylvatica Roxb.
D. candolleana Wight

Symplocaceae :
Symplocos laurina Wall ex Rehd. and Willis

Oleaceae :
Linociera malabarica Wall. ex Don.
Olea dioica Roxb.

Apocynaceae :
Carissa congesta Wight
Rauwolfia densiflora (Wall.) Benth. ex Hook f.
Rauwolfia serpentina (Linn.) Benth ex Kurz.
Alstonia scholaris (Linn. R. Br.
Holarrhena antidysenterica (Roth. A. DC.)
Wrightia tinctoria R. Br.
Chonemorpha fragrans (Moon) Alston
Anodendron paniculatum DC.

Asclepiadaceae :
Hemidesmus indicus Schultes
Cryptolepis buchanani Roem and Sch.
Holostemma annulare (Roxb.) K. Schum.
Cynanchum calliata Ham.
Gymnema sylvestre (Retz.) Schultes
G. khandalense Santapau
Tylophora fasciculata Ham.
T. dalzellii Hook. f.
T. indica (Burm.) Merr.
Dregea volubilis (Linn. f.) Benth. ex Hook f.
Hoya wightii Hook. f.
Ceropegia attenuata Hook.
C. lawii Hook. f.
C. oculata Hook. var. *oculata*
C. hirsuta Wt. and Arn.
C. evansii McCann var. *media* Huber

Loganiaceae:
Strychnos colubrina Linn.

Gentianaceae :
Exacum bicolor Roxb.
E. pumilum Griseb.
E. petiolare Griseb.
E. lawii Clarke
Canscora khandalensis Santapau
Swertia minor (Griseb.) Kno bl.

Boraginaceae :
Coldenia procumbens Linn.
Trichodesma sedgwickianum Benerji
Cyanoglossum wallichii G. Don.

Convolvulaceae :
Ipomoea nil (Linn.) Roth.
I. diversifolia R. Br.
Argyriea malabarica Choisy
A. elliptica Choisy

Solanaceae :
Solanum surattensis Burm.
S. indicum Linn.
S. mccannii Santapau

Scrophulariaceae :
Lindernia crustacea (Linn.) F. Mueller
L. antipoda (Linn.) Alst.
L. ciliata (Colsm.) Pennell
Buchnera hispida Buch. Ham.
Striga gesneroides (Willd.) Vatke
S. gesneroides var. *minor* Santapau
S. asiatica (Linn.) Kuntze
S. lutea var. *albiflora* O. Kuntze
S. densiflora Benth.
S. angustifolia (Don.) Sald.
S. sulphurea D and G
Rhamphicarpa longiflora (Arn.) Benth.
Sopubia delphinifolia G. Don. var. *parviflora* Benth.

Orobanchaceae :
Aeginetia indica Linn.
Aeginetia indica Linn. var. *alba* Santapau
A. pedunculata Wall.
Christisonia lawii Wight.
C. calcarata Wight

Lentibulariaceae :
Utricularia uliginosa Vahl
U. arcuata Wight
U. reticulata Smith
U. reticulata Smith var. *parviflora* Santapau
U. striatula Sm.

Gesneriaceae :
Rhynchoglossum notonianum (Wall.) Burtt

Bignoniaceae :
Oroxylum indicum (Linn.) Vent.
Dolichandrone falcata Seem. var. *lawii* (Seem.) Haines
Heterophragma quadriloculare (Roxb.) K. Schum.
Stereospermum personatum (Hassk.) Chatterjee
Radermachera xylocarpa (Roxb.) K. Schum.

Acanthaceae :
Blepharis asperrima Nees
Hygrophila serphyllum (Nees) Anders.
Hemigraphis latebrosa Nees var. *heyneana* Brem.
Carvia callosa (Nees) Brem.
Calcanthus grandiflorus (Dalz.) Radlk.
Haplanthus tentaculatus Nees var. *tentaculatus*
Neruracanthus trinervius Wight
Dicliptera ghatica Santapau
Justicia betonica Linn.
Rostellularis procumbens (Linn.) Nees
Rhinacanthus nasuta (Linn.) Kurz.

Verbenaceae :
Callicarpa tomentosa (Linn.) Murray
Tectona grandis Linn.
Gmelina arborea Roxb.
Vitex leucoxylon Linn.
Clerodendron viscosum Vent.
C. serratum (Linn.) Moon

Symphorema involucratum Roxb.
Holmskioldia sanguinea Retz.

Labiatae :
Plectranthus mollis (Ait.) Spreng.
Pogostemon purpurascens Dalz.
P. benghalense (Burm.) O. Kuntze
Dysophylla stellata Benth.
Anisomeles heyneana Benth.
Leucas lavandulaefolis Nees

Amaranthaceae :
Aerua sanguinolenta (Linn.) Blume
Alternanthera sessilis (Linn.) DC.

Polygonaceae :
Polygonum plebejum R. Br.

Podostemeceae :
Terniola zeylanica Tul. var. *konkanica* (Willis) Santapau

Piperaceae :
Piper nigrum Linn.

Myristicaceae :
Knema attenuata (Wall.) Warb.

Lauraceae :
Cinnamomum zeylanicum Blume
Actinodaphne angustifolia Nees
Litsea deccanensis Gamble

Thymeliaceae :
Lasiosiphon eriocephalus Decne

Etaeagnaceae :
Elaeagnus conferta Roxb.

Loranthaceae :
Dendrophthoe falcata (Linn. f.) Etting
D. falcata Etting. var. *coccinea* (Talb.) Santapau
D. trigonua (Wt. and Arn.) Danser ex Santapau
Helicanthes elastica (Desr.) Dans.
Helicanthera obtusata (Schutt.) Dans.
Macrosolen capitellatus (Wt'. and Arn.) Dans.
Loranthus phillipensis Cham. and Schlecht.
Taxillus cuneatus (Roth.) Dans.
Tolypanthus lagenifer (Wight) van Tiegh.
Viscum angulatum Heyne ex DC.
V. nepalense Spreng.
V. monoicum DC.

Santalaceae :
Osyris wightiana Wall. ex Wight

Balanophoraceae :
Balanophora indica Wall.

Euphorbiaceae :
Euphorbia pycnostegia Boiss.
E. khandalensis Blatt. and Hallberg
Bridelia squamosa Gehrm.
B. hamiltoniana Wall. ex Hook. f.

Glochidion hohenackeri Bedd.
Putranjiva roxburghii Wall.
Dimorphocalyx lawianus (Muell. Arg.) Hook. f.
Trewia polycarpa Benth.
Mallotus philippinensis (Lamk.) Muell. Arg.
M. stenanthus Muell. Arg.
M. aureo-punctatus (Dalz.) Muell. Arg.
Hura crepitans Linn.

Ulmaceae :
Holoptelea integrifolia (Roxb.) Planch.
Celtis cinnamomea Lindl.
Trema orientalis (Linn.) Blume

Urticaceae :
Fleurya interrupta (Linn.) Gaud.
Boehmeria acabrella (Roxb.) Gaud.
Pouzolzia zeylanica (Linn.) Benn.
Ficus tinctoria Forst. f. *Subsp. parasitica* var. *parasitica* Corner
F. drupacea Thunb. var. *pubescens* (Roth.)
F. nervosa Heyne
F. arnottiana Miq.
F. virens Ait.
F. asperrima Roxb.
F. hispida Linn. f.
F. racemosa Linn.
Antiaria toxicaria (Pers.) Leschera.

Salicaceae :
Salix tetrasperma Roxb.

Monocolyledons :

Hydrocharitaceae :
Blyxa octandra (Roxb.) Planc.

Burmanniaceae :
Burmania pusilla (Wall. ex Miers)

Orchidaceae :
Oberonia recurva Lindl.
Malaxis versicolor (Lindl.) Santapau and Kapadia
Dendrobium microbulbon Rich.
D. sp. (*D. mabelae* Gammie)
D. ovatum (Willd.) Kranz.
D. barbatulum Lindl.
Porpax reticulata Lindl.
Eria reticosa Wight
E. microchilos Lindl.
E. dazlellii Lindl.
Thunia venosa Rolfe
Eulophia ochreata Lindl.
E. epidendraea (Retz.) Fischer
Rhynchostylis retusa (L.) Bl.
Gastrochilus dalzellianus (Santapau) Santapau and Kapadia
Aerides maculosum Lindl.
A. crispum Lindl.
Cottonia peduncularis (Lindl.) Reich. f.
Nervilia infundibulifolia Blatt. and Mc. C.
N. carinata (Roxb.) Schltr.

Peristylus stocksii (HK. f.) Kraenz.
Platanthera susannae (Linn.) Lindl.
Habenaria digitata Lindl.
H. gibsoni Hook f. *H. gibsoni* var. *foliosa* (A. Rich.) Santapau and Kapadia.
H. rariflora A. Rich.
H. ovalifolia Wight.
H. marginata Coleb.

Zingiberaceae :
Kaempferia scaposa (Nimmo) Benth.
Hitchenia caulina (Graham) Baker
Curcuma pseudomontana Graham
C. purpurea Blatt.
Zingiber cernuum Dalz.
Zingiber macrostachyum Dalz.
Costus speciosus (Koenig) Smith

Marantaceae :
Stachyphrynium spicatum (Roxb.) Schum.
Phrynium capitatum Willd.

Musaceae :
Ensete superbum (Roxb.) Cheesman

Hypoxidaceae :
Hypoxis aurea Lour.
Curculigo orchioides Gaertn.

Amaryllidaceae :
Crinum latifolium Linn.
C. asiaticum Linn.
Pancratium sanctae-mariae Blatt. and Hallberg

Agaveaceae :
Agave ingens Berger

Dioscoreaceae :
Dioscorea pentaphylla Linn.
D. bulbifera Linn.
D. oppositifolia Linn.
D. belophylla Voigt

Liliaceae :
Asparagus racemosus Willd. var. *javanica* Baker
Gloriosa superba Linn.
Iphigenia indica (Linn.) A. Gray
Scilla viridis Blatt. and Hallberg
Chlorophytum tuberosum (Roxb.) Baker
C. glaucum Dalz.
C. orchidastrum Lindl.

Smilaceae :
Smilax zeylanica Linn.

Commelinaceae :
Commelina suffruticosa Blume
Murdannia spirata (Linn.) Brueckner
M. malabarica (Linn.) Brueckner
Cyanotis tuberosa (Roxb.) Schult.
C. fasciculata (Heyne ex Roth) Schult. f.

Palmae :
Caryota urens Linn.
Phoenix sylvestris Linn. (Roxb.)
Borassus flabellifer Linn.

Typhaceae :
Typha angusta Bory and Chaub.

Araceae :
Cryptocorine spiralis (Retz.) Fisch. ex Wydler
Arisaema murrayi (Graham) Hook.
A. tortuosum (Wall.) Schott.
A. neglectum Schott.
A. leschenaultii Bl.
Sauromatum guttatum (Wall.) Schott.
Amorphophallus commutatus (Schott.) Engler
A. bulbifer (Roxb.) Blume
Ariopsis peltata Nimmo
Remusatia vivipara (Roxb.) Schott.

Potamogetonaceae :
Potamogeton indicus Roxb.

Eriocaulaceae :
Eriocaulon dianae Fyson
E. humile Moldenke
E. indicum Moldenke
E. lanceolatum Mig. var. *pilosum* Moldenke
E. santapaui Moldenke
E. gracile Mart.

Cyperaceae :
Cyperus albomarginatus Mart. and Schrad ex Nees.
C. articulatus Linn.
C. brevifolius (Rottb.) Hassk.
C. compressus Linn.
C. iria Linn.
Fimbristylis bisumbellata (Forsk.) Bub.
F. digitata Boeck

Gramineae :
Arthraxon hispidus (Thumb.) Makino
Arthraxon inermis Hook. f.
A. lancifolius (Trin.) Hochst
A. meeboldii Stapf.
Arundinella pumila (Hochst) Steud.
Bambusa arundinacea (Retz) Willd.
Bhidea burnsiana Bor
Bothriochloa compressa (Hook. f.) Henrard
Chionachne koenigii (Spreng.) Thw.
Coix lachryma-jobi Linn.
Cymbopogon martini (Roxb.) Wats.
Digitaria adscendens (H. B. K.) Henrard
Dimeria ornithopoda Trin.
Echinochloa colonum (Linn.) Link.
Eragrostis diarhena (Schult.) Steud.
E. pilosa (Linn.) Beauv.
E. unioloides (Retz.) Nees ex Steud
Heteropogon contortus (Linn.) Beauv.
H. triticeus (R. Br.) Stapf ex Graib
Hygrorhiza aristata (Retz.) Nees
Indopoa paupercula (Stapf) Bor

Isachne globosa (Thunb.) O. Kuntze
Ischaemum indicum (Houtt.) Merr.
I. diplopogon Hook. f.
I. semisagittatum Roxb.
Jansnella griffithiana (C. Muell.) Bor.
Melanocenchris jacquemontii Jaub. and Spach.
Oplismenus compositus (Linn.) Beauv.
Panicum psilopodium Trin.
Paspalum compactum Roth.
Sehima nervosum (Rottl.) Stapf
Setaria glauca (Linn.) Neauv.
Spodiopogon rhizophorus (Steud.) Pilger
Themeda quadrivalvis (Linn.) O. Kuntze
Tripogon ramosissimus (Hack.) Bor
Vetiveria zizanoides (Linn.) NASH

Besides the flowering plants a large number of ferns, mosses and liverworts grow at Khandala and Lonavala.

4.8 : *Flora of Sakharpathar, Ambavne* :

This lies to the west of Pune at the edge of Deccan plateau in the Mawal and Mulshi talukas of Pune district adjoining Raigad district. Sakharpathar is a flat plain 900 m high and 5 km distant from Lonavala. It is difficult to approach in rainy season, but in other seasons it can be reached by a *kuchcha* road from Lonavala or by a similar road from Mulshi. Ambavne is still further, 23 km from Lonavala. The high level plateau has deep ravines and groves towards Raiagad district.

Being in the heavy rainfall zone the heavy rains are more than 100″ and last from June to October. The soils are derived from basalt. They have been ripened in the heavy rainfall area, and as such, are not dark. They contain plenty of humus with gravel and disintegrated trap. They are however not deep nor have much ground cover. B. V. Reddi (1969) has described the plants of this area in *Bull. Bot. Surv. India*, in Vol. 11 : 138—149 : 249—259 ; and Vol. 12 : 213—225. The list of important plants is given below. The cultivated and very common plants are omitted, and only characteristic species are given in the list here.

The vegetation at high altitude contains temperate plants like *Cardamine tichocarpa*. The ravines have evergreen and semi-green trees like *Garcinia indica, G. talboti, Erinocarpus nimmonni*, and also dry species like *Kydia calicina, Capparis moonii, Sterculia guttata, Frimania coloraca, Dysoxylum binectariferum, Gymnosporia rothiana, Tregea edgeworthii, Allophyllus serratus, Schleichera oleosa*, and a number of monsoon ephemeral, herbaceous plants occur, especially the legumes such as *Smithia* species. Seven species of it occur here. Among evergreen trees at the edge of the Sahyadris, *Memecylon umbellatum, Pimpinella* species are common. The vegetation consists of a mixture of evergreen and semi-evergreen species.

Flora of Sakharpathar and Ambavne Region of Pune District
(from B. V. Reddi, 1969, 1970)

Ranunculaceae :
Clematis hedysarifolia DC.

Dilleniaceae :
Dillenia pentagyna Roxb.

Annonaceae :
Meiogyne pannosa (Dalz) Sincl.
Miliusa tomentosa (Roxb.) Sincl.
Sageraea laurifolia (Grah.) Blatt.

Menispermaceae :
Cissampelos pareira Linn.
Cyclea burmanni (DC.) HK. f. and Th.
Diploclisia glaucesens (Bl.) Diels
Stephania japonica (Thunb.) Miers.

Brassicaceae :
Cardamine trichocarpa Hochst. ex Rich
Rorippa indica (Linn.) Hiern

Capparidaceae :
Capparis moonii Wight.
C. spinosa Linn.

Cleome chelidonii Linn. f.

Flacourtiaceae :
Flacourtia indica (Burm. f.) Merr.
F. montana Grah.

Pittosporaceae :
Pittosporum floribundum Wt. and Arn.

Caryophyllaceae :
Polycarpon prostratum (Forsk.) Asch. and Sch.

Guttiferae :
Garcinia indica (Du pet. Thou.) Choiss.
G. talbati Raiz. ex Sant.
Mammea suriga (Bach-Ham. ex Roxb.) Kost.

Ancistrocladaceae :
Ancistrocladus heyneanus Wall.

Malvaceae :
Abelmoschus manihot (Linn) Medic
Abutilon polyondrum Sch.
Kydia calycina Roxb.

Bombacaceae :
Bombax ceiba Linn.
B. insigne Wall.

Sterculiaceae :
Eriolaena quinquelocularis Wight.
Firmiana colorata (Roxb.) R. Br.
Helicteres isora Linn.
Sterculia guttata Roxb.
S. urens Roxb.

Tiliaceae :
Erinocarpus nimmonii Grah.
Grewia acutilifolia Vent. ex Juss.
G. disperma Rottl. ex. Spr.
G. tiliaefolia Vahl. var. *argentea* Burr.

Elaeocarpaceae :
Elaeocarpus oblongus Gaertn.

Linaceae :
Reinwardtia trigyna (Roxb.) Planch.

Malphigiaceae :
Aspidopterys cordata (Heyne) A. Juss.
Hiptage benghalensis (Linn) Kurz.

Balsaminaceae :
Impatiens acaulis Arn.
I. balsamina Linn.
I. kleinii Wt. and Arn.
I. oppositifolia Linn.
I. pulcherrima Dalz.

Rutaceae :
Atalantia racemosa Wt. and Arn.
Evodia lunu-ankenda (Gaertn.) Merr.
Fagara budrunga Roxb.
Glycosmis mauritiana (Lamk.) Tanaka
Murraya koenigii (Linn) Spr.
Paramignya monophylla Wight
Toddalia asiatica (Linn) Bamk.

Burseraceae :
Canarium strictum Roxb.
Garuga pinnata Roxb.

Meliaceae :
Amoora lawii (Wight) Bedd.
Dysoxylum binectariferum (Roxb) Hook. f. ex. Bedd.
Melia composita Willd.
Toona ciliata Roem.

Olacaceae :
Olax wightiana Wall. ex. Wt. & Arn.
Strombosia ceylanica Gardn.

Opiliaceae :
Cansjera rheedii Gmel.

Icacinaceae :
Nothopodytes foetida (Wt.) Sleumer.

Hippocrateaceae :
Gymnosporia rothiana (Wt. & Arn.) Laws.
Reissantia grahami (Wt.) Ding. Hou.
R. indica (Willd.) Hall.

Rhamnaceae :
Rhamnus trigueter (Wall.) Brand.
Ventilago madraspatana Gaertn.
Zizyphus glaberrima Sant.
Z. rugosa Lamk.

Vitaceae :
Cissus discolor Bl.
C. elongata Roxb.
C. repanda Vahl.
Tetrastigma camarense (Dalz.) Gamble.

Leeaceae :

Leea edgeworthii Sant.
Leea indica (Burm. f.) Merr.
L. robusta Roxb.
L. setuligera Cl.

Sapindaceae :

Allophylluss serratus (Roxb.) Radlk.
Lepisanthes tetraphylla (Vahl.) Radlk.
Schleichera abeosa (Lour.) Oken

Anacardiaceae :

Anacardium occidentale Linn.
Holigarna grahami (Wt.) Hook. f.
Lannea coromandelica (Houtt.) Merr.

Connaraceae :

Rourea santaloides Wt. & Arn.

Fabaceae :

Aeschynomene indica Linn.
Alysicarpus belgaumensis Wight
A. vaginalis (Linn.) DC.
Atylosia lineata Wt. & Arn.
A. scarabaeoides (Linn.) Benth.
A. sericea Benth. ex Baker
Butea monosperma (Lamk.) Taub.
Cassia filipes Benth.
C. nana Burm. f.
C. retusa Linn.
C. vestita Baker
Cylista scariosa Roxb.
Dalbergia lanceolaria Linn.
D. sympathetica Nimmo ex Roxb.
D. triangulare (Relz.) Merr.
Erythrina stricta Roxb.
Geissaspis cristata Wt. & Arn.
Moghania gracilis Mukh.
M. strobilifera (Linn.) St. Hil. ex Jacks.
Mucuna monosperma DC.
M. prurita Hook.
Phaseolus dalzellii Cooke
Smithia bigemina Dalz.
S. blanda Var. *racemosa* Baker
S. conferta Sm.
S. purpurea Hook.
S. pycnantha Benth. ex Baker
S. sensitiva Ait.
S. selulosa Dalz.
Teramnus labialis (Linn. f.) Spr.
Vigna capensis Walp.
Zornia gibbosa Span.

Caesalpiniaceae :

Bauhinia foveolata Dalz.
B. racemosa Lamk.
Cassia mimosoides Linn.
C. fistula Linn.

Mezoneuron cucullatum (Roxb.) Wt. & Arn.
Wagatea spicata Dalz.

Mimosaceae :
Acacia chundra (Roxb.) Willd.
A. nilotica (Linn.) Del. SSp. *indica* (Benth.)
A. sinuata (Lour.) Merr.
A. torta (Roxb.) Craib
Albizzia chinensis (Osb.) Mer.

Crassulaceae :
Kalanchoe pinnata (Lamk.) Pers.

Droseraceae :
Drosera indica Linn.

Rhizophoraceae :
Carallia brachiata

Combretaceae :
Anogeissus latifolia (Roxb.) Bedd.
Calycopteris floribunda (Roxb.) Lamk.
Combretum latifolium Bl.
C. ovalifolium Roxb.
Terminalia bellerica (Garrtm.) Roxb.
T. chebula Retz.
T. crenulata Roth.

Myrtaceae :
Syzygium canarensis Talbat
S. cumini (Linn.) Skeels.
S. jambos (Linn.) Alston
S. phillyraeoides (Trim.) Somt.

Lycythidaceae :
Careya arborea Roxb.

Melastomataceae :
Memecylon talbatianum Brandis
M. umbellatum Burm. f.
Osbeckia truncata Don.
Sonerila scapigera Hook.

Lythraceac :
Ammannia baccifera Linn.
A. multiflora Roxb.
A. senegalenis Lamk.
Lagerstroemia lanceolata Wall. ex Wt. Arn.
L. parviflora Roxb.
L. speciosa (Linn.) Pors.
Rotala densiflora (Roxb.) Kochne
R. floribunda (Wt.) Kochne
R. ocultiflora Kochne.
R. serpyllifolia (Roth.) Bremek
Woodfordia fruticosa (Linn.) Kurg

Onagraceae :
Ludwigia octovalvis (Jacq.) Raven SSP. *sessiliflora* (Mich) Raven.
L. perennis Linn.

Samydaceae :
Casearia graveolens Dalz.

Cucurbitaceae :
Dicoelospermum ritchici Cl.
Momordica dioica Roxb. ex. Willd.

Begoniaceae :
Begonia concanensis DC.
B. crenata Dryand.

Molluginaceae :
Glinus lotoides Linn.

Apiaceae :
Centella asiatica (Linn.) Urban
Heracleum concanense Dalz.
Peucedanium grande Cl.
Pimpinella adscendens Dalz.
P. heyneana Wall. ex Kurz
P. monoica Dalz.
Trachyspermum stictocarpum Wulff Var. *hebecarpum* (Cl.) Wulff.
T. strictocarpum Wolffl var. *stictocarpum* Wulff.

In addition to theabove,the following plants noted by B. Venkata Reddi (1970) at Ambavne Sakharpathar in *Bull. Bot. Sur. India*, vol. 12, pp 213—225 are worthy of note :

Droseraceae :
Drosera indica

Podostemaceae :
Dicracia stylosa Wight
Griffithella hookeriana Warming
Podostemon subulatum Gardn.
Terniola zeylanica Tul. var. *Konkanica* (Willis) & Sant.

Piperaceae :
Peperomia wightiana epiphytic on *Memecylon umbellatum*

Loranthaceae :
Tolypanthus laginifer Van Tiegh.

Balanophoraceae :
Aroblasts *ambavanensis* Reddi

Araceae :
Ariopsis hastata Ninrmo

Burmanniaceae .
Burmannia pusilla Thw.

4.9 : *Flora of Bhimashankar* :

Bhimashankar is another important area of flora at an altitude of 3448′ above M.S.L., 1000′ more in height than Matheran. It lies 19°.04′ N, 73°.32′E in Khed taluka and is known to be an important place of pilgrimage. It is one of the twelve *Jyotirlingas*, about 90 km from Pune. It is 48 km from Khed. It has a flat top, narrow and steep gorges and deep ravines. It lies, near the village Bhovargiri. Peth and Godavari ghat are closeby, Shinga and Kondaleshwar hills lie in the vicinity. The river Bhima rises from here and is joined by other small rivers like Bhama, Meena, Ghod, Kukadi, all rising in the vicinity.

The climate due to high altitude and presence of dense forests on one side is cold and dry. On the other sides the trap hills and plains are very dry. It lies on a crest of Sahyadri ranges. The rainfall is about 502 cm, but it becomes much less in the rain shadow region on the other side. Much of it falls in July-August and decreases after September-October. Humidity is 90 to 100% in rainy season. In other seasons it is 70% in the morning, but at noon 20—25%; naturally the plants dry up from January-February and hills look dark and barren.

Ratio of humid to drought period is 5 : 7. Rainfall is less than other hill stations at the edge of Sahyadris 523 cm per year. At Alandi in the rain shadow it is only 25·5 cm.

Hills are all trap hills. They disintegrate into coarse soil or gravel as the basalt here is mostly amygdaloidal. Soils are light, not very fertile being alkaline.

Drainage is from NW to SE, but the winds blow just in the opposite direction. Storms and hails are rare.

The vegetation here is largely determined by altitude, rainfall and poor soils. It consists of the following types:—

(1) Semi-evergreen around Bhimashankar,

(2) Deciduous about Maral, Ambegaon and Khed,

(3) Thorn scrub about Shivaneri.

(4) Low scrub at Gargatwadi and in region towards Shirur and Hardi. Open grasslands occur due to poor rainfall (about 75 mm) at Ambathan in Haveli taluka and at Shirur. The hill tops and flats have only low grass.

(1) *Semi-evergreen forests.*—These occur at 900 m and above in the valleys and ravines, but they also dry up in some places in summer. Here the evergreen species, especially trees are dominant and they have to struggle for space and light. A good example of it is seen in Rai wood near Bhimashankar. At Bhovargiri vegetation is dominated by *Memecylon umbellatum* and *Atlantia racemosa*. In the Rai wood proper occur *Olea dioeca, Litsea stocksi Symplocos beddomii, Helerophragma roxburghii, Actinodaphne angustifolia Allophyllus rheedii, Bridelia retusa, B. squamosa, Murraya paniculata and Mangifera indica*. In addition to them *Syzygium cumini* is common. *Leea indica, Ancistrocladus latifolia*. One frequently finds *Hoya carnosa* on the outskirts of forests. In Rai wood shrubby vegetation consists of *Carissa congesta, Thelspacpale ixiocephala, Carvia callosa, Acacia torta* etc.

Climbers are *Ventilago bombaiensis, Porana malabarica, Gymnema sylvestris, Cylista* sp.

Herbaceous species and grasses occupy open spaces. Xerophytes, tuberous plants like *Chlorophytum glaucum*, ground orchids like species of *Habenaria* seem to dominate soil cover. At other places like *Vanda* proportion of semi-evergreen species becomes less. They imperceptibly merge into strands of deciduous species like *Terminalia chebula, T. bellerica, Clematis gauriana, Hemidesmus indicus. Piper longum, Zizyphus rugosa*. Several *Striga* sps., also are met with. Orchids *Dendrobium barbatum, Oberonia recurva, Aerides maculosum*, several mosses, occur on

the trees in these forests. In the stream in Rai wood *Terniola zeylanica* var. *Konkanica* Sant. is found. In Bhima river bed on rocks *Griffithella macrocephala* is seen floating in waters.

(2) *Tropical Deciduous forests.*—These are found on hill flats and plateaux at lower levels. Unlike semi-evergreen forests they are continuous near Biti, Kondaleshwar etc. They consist of *Tectona grandis Terminalia crenulata, T. chebula, T. bellerica, Ficus racemosa, Anogeissus latifolia, Semicarpus anacaridum, Wrightia tinctoria, Certia malabarica* etc.

Secondary species are *Bridelia squamosa, Lagerstroemia lancelata, Albizzia amara, Acacia arabica* and *Euphorbia neriiolia.* Common shrubs are *Woodfordia fruticosa, Clematis triloba* etc. Common grasses *Cymbopogon martini, Lophoponon tritentatus, Aristida stocksii* are plentiful.

(3) *Scrub or thorn savanna.*—On Eastern side of Bhimashankar there is scrub jungle consisting of *Carissa congesta, Lantana camara* var *aculeata Cassia aurimalata Plumbago zeylamica, Zizyphus glaberama,* woody climber of *Dregea volubilis* and small grasses. *Acacia leucophloea* and *Balanites roxburghii* occur here and there.

(4) *Open grasslands.*—These occur on gravel and open slopes of small hills and on unfertile plains during monsoons. Common grasses are *Themeda quadrangulare, Cymbopogon martini, Heteropogon contortus,* together with some legumes. But the edible fodder grasses are poor. They yield not enough fodder for the cattle here. It dries up soon due to surface soil getting dry. Weeds also are plenty and they also dry up.

On the other hand, in the valley and on plains where soil, is good *papaya, Citrus* and *Punica granatum* plantations develop well.

Monsoon ephemeral flora is not spectacular. Flora of Bhimashankar is not published. There are many medicinal plants in the hills of Khed taluka. They have been studied by K. P. Janardhanan (1963) and are enumerated by him in *Bull. Surv. India.* Vol. 5 (3-4) : 363-374 and in *Abstract Ind. Sc. Con.* 1968. Some earlier collectors like Kanitkar, Bhide, H. P. Paranjpe had noted some plants of this area, but there has been no comprehensive account of them. It is highly needed as Maharashtra Government is opening Naneghat Ghat route to Bombay which will shorten the distance by about 64 km to Bombay from Ahmadnagar, Aurangabad etc. As a matter of fact, this was the old Moghul trade route. Another reason is that the Government has been trying to harness the rivers Ghod, Kukadi and Meena to irrigate the areas of Shirur in Pune District, Shrigonda, Parner and Karjat in Ahmadnagar, and Karmala in Sholapur. Bhimashankar also could be a hill resort on account of its cool dry climate.

4.10 : *Vegetation of Junnar Area* :

Junnar lying on 19°.12′ North latitude and 73°-53′ East long. is an old taluka town known as Jeern nagar, 80 km. from Pune. It is on the leeward side of Sahyadri but a little in the interior. The area to its west receives 125 cm of rain but decreases towards east to 35 cm only. The vegetation naturally is not at all uniform. The area is uneven. There are many water-logged depressions. In the area near the crest of Sahyadri there

are semi-evergreen forests, generally in the ravines and valleys. On the Desh side there are deciduous forests which become sparser and sparser towards south and merge with scrub. In many ponds and water-logged areas aquatic plant communities and marshy plants grow.

Junnar town is surrounded by hills 183-330 m high above the ground; closeby there is Manmoda Ghat about 5 km north, and Shivaneri Fort to the west. The rivers Kukadi and Pushpavati drain the area. To the north-west of Kukadi river there is a vast cuplike depression. A dam is being constructed on Kukadi. The drainage is from NW to SE.

The rocks are derived from 6-8 trap flows which are mostly amygdaloidal and full of quartzs. Soils of various colour are formed from them in Kukadi basin. They are gravelly and unfertile; they are reddish due to laterite. Some soils are black, mixed with plenty of salts and forest debris. They are fertile. Rainfall at Junnar had been variable. Temperature 43.4° C is maximum and 25.21° C minimum, generally 29.30°.C. The climate is warm, but mild, dry after monsoons and pleasantly cold in winter. Humidity varies from 41% to 75%. Mean maximum temperature in May is 42.7°C and mean minimum is 17.6°C in December. In January it could be still as low as 9.7°C. Sometimes bitter cold winds blow in winter and also hail storms. Dust storms occur in early days of monsoons. The climate in the Ghat areas however is always mild and uniform. This is highly favourable for plant growth in forests and for the agricultural crops. Malvand and Borvand areas are very fertile. Otherwise people grow only *Setaria italica* and *Eleusine coracana* on unfertile gravelley soils of hill tops and slopes.

The rivers Kukadi, Meena, Pushpavati and many streams provide ample water to Junnar area. Lenyadri hill is closeby on the road going to Ozar. There is the famous Ganapati temple at Ozar which is one of the eight self-born shrines of Vinayak. Shivaneri fort famous as the birth place of Shivaji stands on the hill on outskirts of Junnar. Closeby from it passes the Malshej ghat which is really at the junction of Pune, Ahmadnagar and Nasik districts. It is about 8 km from Desh to Konkan plains below.

Vegetation.—The region has been studied by a few botanists like Gibson, Cooke, Woodrow, Bhide, H. P. Paranjpe, Bhiva, Puri and Mahajan, Vasavda, Jain, Ansari etc. Of these Gibson had established a botanical garden and an arboratum at the river bend near the village Hiwre, on river Kukadi in Junnar taluka. It is now submerged under the Kukadi dam.

There are some Dev-Raies here e.g. Durgabaichi Rai, Dhakobachi Rai. In and around them for some distance and in the valley of hills there is semi-evergreen vegetation consisting of *Sterculia guttata Terminalia crenulata*, *Lagerstroemia lanceolata*, *Dillenia polygyna*, *Kydia, calycina*, *Mangifera indica*, *Syzygium cumini* etc. Around this is a circle of *Carvia callosa* and small thorny scrubs. In the Raies there are woody climbers of *Bauhinia vahlii*, and then all of a sudden there is dry deciduous forest vegetation of *Tectona grandis*, *Terminalia chebula*, *T. bellerica*, *Diospyros heterophylla*, several *Acacias* and *Balanites roxburghii*. This in its turn changes into scrub and then into pastures or open grasslands.

At the edge of hills on the Sahyadri ranges there are plenty of trees of *Memecylon umbellatum* which when flower at the end of winter they form a gorgeous sight. On the river banks and streams *Bauhinia racemosa* and *Ficus* grow to fairly good size. In the grasslands many fodder as well as fibre and thatch grasses grow and so also the weeds.

Since the place was not frequently visited, many new records of species not known to grow have been made out by the members of the Botanical Survey of India, Western Circle. Some 9-10 new species of grass, *Arthoxylon*, *Manisuris*, *Ischemum*, a species of *Chlorophytum*, several new species of *Ceropegia* and a new genus *Seshagiria* are established by K. Hemadri ,Ansari, Jain and others.

There are some rare plants, medicinal, economic and endemic. The world famous endemic Asclepiad, *Frerrea indica* was first discovered here from the edges of rocks and walls of Junnar fort nearly hundred years ago. There was no trace of it when McCann found it below Kate's point at Mahabaleshwar and Santapau found it at Vazirgad in Purandar fort. The plant is on way to extinction and is now seen in botanical gardens only.

The vegetation of Junnar fort is remarkable. It presents strong contrast all of a sudden by dry deciduous species or scrub around the semi-evergreen vegetation in Dev-Raies and valleys. This is no doubt due to high arid hills of Sahyadris at the west and north and vast dry plains of Desh on the other sides. Dr. Gibson's Park at Hiwre looks like an oasis in the midst of a dry semi-desert hills and low woodland savannah.

4.11 : *Gibson's Forest Park and Botanical Garden at Hiwre* :

Hiwre is a small village in Junnar taluka on the bank of river Kukadi on its bend. The river rises in a higher nearby region of Sahyadri and brings down a lot of soil both by erosion and by its floods. Seeing the abundance of water, cool climate, variety of soil, Dr. Alexander Gibson chose this area in 1840 for a park and experimental garden for acclimatisation and improvement of economic species, and introduction of new species both from India and abroad which could be grown here. The park at Hiwre was the outcome of the great insight in forestry and plant life that Dr. Gibson had and his rich experience both as a botanist and as a forester.

Dr. Gibson's Forest Park at Hiwre had been a unique achievement and was one of the few such gardens in India at that time and even afterwards. A similar park was established on a large area more than 150 acres by J. F. Duthie, (the author of the *Flora of the Upper Gangetic Plains*) at Saharanpur which is now the garden of L. R. Brothers, Seedsmen and Nurserymen at Saharanpur.

Alexander Gibson came to India (Bombay) in 1825 to serve as a Medical Officer in the service of the East India Shipping Company of England[1]. In view of his deep knowledge of trees, Dr. Gibson was appointed the first Conservator of Forests in the newly created Forest Department in Bombay, on 19th December 1846. At that time the forests were looked after by the Revenue Department, the auctions of timber and other materials from

[1] Details of his life sketch are given in last chapter of this volume.

forests were made by the Military Department, and the whole thing was under the supervision of the Political Department. This three-fold control was always creating a lot of difficulties in his work. Many stands of rich forests of precious timber trees Teak, (*Tectona grandis*), *Myrobalans*, *Adina cordifolia* were being continuously cut down and destroyed. He also found that in the midst of thick forests both in North Kanara and elsewhere, there was a practice of 'Kumli' cultivation, whereby cultivators used to get higher yield of food crops by burning trees in the midst of forests before sowing crop seed. He devised laws regarding the removal of dead wood from the forests by the local people, chopping of side branches free of cost, inducing the local people to look after forests in the vicinity. He made spectacular contribution towards forest management.

After finishing his term of service he started the Forest Park at Hiwre. Here he built an Arboretum, made collection of many economic trees, medicinal plants and also other plants and built an herbarium. Several tree species were particularly brought from other parts of India like Assam, Mysore, Malabar, and he tried to grow them together, blending them with local ones. He had also brought plants from other countries e. g. *Adansonia digitata, Bauhinia purpurea, Anacardium occidentale, Casuarina equisetifolia, Castiloa elastica,* different *Terminalias, Dalbergias, Putrajiva roxburghii, Lannaea glauca, Haematozylon campechianum, Milingtonia hortensis, Diospyros cordifolia, Pterospermum heyneanum, Gmelina arborea* and several such useful woody species. A nursery for growing and acclimatising their seedlings, study of the micro-climate suitable to them was established. Growth habits and performance of exotic plants in the semi-arid climate of Hiwre and in the whole of Maharashtra were studied. A garden of ornamental and medicinal plants was also established. In course of years, the trees that he had grown were mingled with the semi-arid species of local plants such as *Ceiba malabarica, Tamarindus indica, Acacias,* etc. The experiments were successful because both the exotic and indigenous species grew to their full height, and it looked as if they had reached climatic climax in the new ecosystem.

In 1860 Dr. Gibson retired from the position of the Conservator of Forests, Bombay, and went abroad. He was followed by his successor Dr. Stocks. He came back to Hiwre and died later at Bombay on 18th January 1867. But before that he had developed the Hiwre Garden to a great extent. His remains were buried in Hiwre Garden close to his residence, and his wife raised a huge monument in his memory. She even bequeathed the whole garden and park to the Forest Department which was supposed to look after them. His residence close to the memorial became the Forest Department Rest House for Forest Officers. Till 1942, however, the garden did not seem to have been well maintained or looked after as was originally planned by Gibson. In 1942, however, the Forest Department took over the management more seriously and declared it as a Preservation Plot, cutting down the tamarind and other wild local trees. They also wanted to develop various sections in the park namely (1) timber species, (2) fire wood species, (3) medicinal plants, (4) fruit trees, (5) minor forest produce plants, (6) ornamental plants, and (7) plants of botanical interest and those required for scientific research etc. Dr. Gibson's monument still stood after repairs and renovation; but the whole garden and the area was submerged under the high level dam on the Kukadi river for irrigation, and hydro-electric purposes. The main dam on Kukadi has already been constructed and much of the garden is submerged.

LIST OF PLANTS AT HIWRE PARK OF DR. GIBSON, TILL MARCH 1971

Annonaceae :
Miliusa tomentosa (Roxb.) J. Sm.
Annona squamosa Linn.
Polyalthia longifolia Benth. & Hook f.

Menispermaceae :
Stephania hernandifolia Walp.

Capparidaceae :
Capparis sepiaria Linn.

Malvaceae (Bombacaceae) :
Bombax ceiba Linn. f.
Adansonia digitata Linn.
Cordia dichotoma Forst. f.

Sterculiaceae :
Guazuma ulmifolia Ham.
Pterospermum heyneanum Wall.

Tiliaceae :
Erinocarpus nimmoanus Grah.
Grewia tiliaefolia Vahl.

Elaeocarpaceae :
Elaeocarpus sphaericus K. Schum.

Rutaceae :
Feronia limonia Sur.

Simarubaceae :
Ailanthus excelsa Roxb.
Balanites roxburghii Planch.

Meliaceae :
Azadirachta indica A. Juss.
Chloroxylon swietenia DC.
Swietenia mahogoni Linn.

Rhamnaceae :
Dodonaea viscosa Linn.
Sapindus emarginatus Vahl.
=*S. trifoliatus* Linn.
Schleichera oleosa O. Ken.

Anacardiaceae :
Lannea coromandelica (Houtt.) Merr.
Mangifera indica Linn.

Papilionaceae (Leguminosae) :
Dalbergia latifolia Roxb.
D. melanoxylon Guill.
D. paniculata Roxb.
D. sissoo Roxb.
Pongamia pinnata Benth.

Caesalpiniaceae (Caesalpinae-Leguminosae) :
Bauhinia diphylla Buch.-Ham.
B. purpurea Linn.
B. racemosa Lamk.

B. vahlii W. & A.
Caesalpinia dicapetala Alston
C. coriaria Willd.
C. pulcherrima Sw.
Cassia fistula Linn.
Haematoxylon campachianum Linn.
Saraca indica Linn.
Tamarindus indica Linn.

Mimosaceae (Mimosae-Leguminosae) :
Acacia catechu Willd.
A. leucophloea Willd.
A. nilotica Del. ssp. *indica*
A. summa Buch.-Ham.
Adenanthera pavonina Linn.
Albizzia amara Boiv.
A. lebbek Benth.
Leucaena glauca Poenth.

Combretaceae :
Terminalia arjuna W. & A.
T. bellirica Roxb.
T. crenulata Roth.

Cornaceae :
Alangium salviifolium (Linn. f.) Wang.

Rubiaceae :
Ixora arborea Roxb. Ed sm.
—*I. parviflora* Vahl.

Sapotaceae :
Madhuca indica Gmel.

Ebenaceae :
Diospyros cordifolia Roxb.
D. melanoxylon Roxb.
D. montana Roxb.

Oleaceae :
Schrebera swietenioides Roxb.

Apocynaceae :
Carissa congesta Wight.

Bignoniaceae :
Heterophragma quadriloculare K. Sch.
Millingtonia hortensis Linn.
Stereospermum xylocarpum B. & H. F.

Loganiaceae :
Strychnos nux-vomica Linn.

Verbenaceae :
Gmelina arborea Roxb.
Tectona grandis Linn.

Santalaceae :
Santalum album Linn.

Euphorbiaceae :
Aleurites moluccana Willd.
Cicca acida (Linn.) Merr.

Euphorbia antiquorum Linn.
E. tirucalli Linn.
Putranjiva roxburghii Wall.

Urticaceae :
Castiloa elastica Cerv.
Holoptelea integrifolia Planch.
Ficus bengalensis Linn.
F. elastica Roxb.
F. glomerata Roxb.
F. religiosa Linn.

Agavaceae :
Agave sisalana Per.

Palmaceae :
Caryota urens Linn.
Phoenixsylvestris Roxb.

4.12 : *List of Plants in Pune and nearby districts by Dr. B. A. Razi* (1952) :

(Arrangement of families is as per Engler and Diels 1936, *syllabus der Pfianzen families*).

Pandanaceae :
Pandanus Sp. .. .. .. Parwati

Potamogetonaceae :
Potamogeton indicus Roxb. .. Parwati

Gramineae :
Euchlaena americana Schrad
Zea mays Linn. .. .. .. Sinhagad, Panchgani
Chionachne semiteres (Benth.) .. Law College hill, Pune
=*Polytoca barbata* Benth. .. Round Junnar
Ischaemum ciliare Retz. .. .. Ganeshkhind
I. diplopogon Hook. f. .. .. Bhorkas near Pune
I. pilosum Hack. .. .. .. Chatushringi, Kalas near Lonavala
I. semisagittatum Roxb.
Schima nervosum Stap f. .. .. Panchgani
Schima spathiflorum Blatter and Mc Cann. Lohagad plain, Bhairawadi near Purandar.
S. sulcatum A. Camus .. .. Kalas near Lonavala
=*Ischaemum sulcatum* Hack. ..
Pollinidium binatum (Retz.) C. E. Hubbard. Cultivated at Pune
Thelepogon elegans Roth. .. Katraj ghat
Lophopogon tridentatus Hack. .. Chatushringi, Kalas near Lonavala
Apluda aristata Linn. .. .. Kalas, Ganeshkhind
=*A. varia* Hack.
A. aristata Hack. .. .. Purandar.
Rottboellia exaltata Linn. f. .. Agriculture College, Pune
R. robusta Hook. f. Poona .. Purandar
Saccharum officinarum Linn .. Cultivated
S. spontaneum Linn. .. .. Pune on river bank
Spodiopogon albidus Benth. .. Ganeshkhind, Sinhagad, Lohagad
Eulalia argentea Brongn. .. Lohogad
Bothriochloa pertusus (Willd.) .. Agriculture College Campus, Pune

=*Andropogon pertusus* Willd.	Kalas near Lonavala
Arthraxon. inermis Hook. f.	Purandar
A. jubatus Hack.	Top of Lohagad
A. lanceolatus Hochst.	Pune, Law College hill
A. lancifolius Hochst.	
=*A. microphyllus* Hochst.	Pune, Law College hill
A. serrulatus Hochst.	Pashan tank
Capillipodium filiculinis (Hook. f.) Stapf.	Pune. Purandar
Amphilophis compressus Blatter and MacCann.	Pune
A. odorata A. Camus	At foot of Lohagad, Mawal
A. pertusa Stapf.	Pashan, Agriculture College, Pune
A. woodrowii A. Camus	
A. squarrosus Hook. f.	
Sorghum halpense (Linn.) Pers.	Pune, Purandar
=*Andropogon halpensis* Brot.	Ganeshkhind
S. purpureo-gericeum Aschers.	Kalas near Lonavala
Chrysopogon montanus Trin	Kirkee, Pashan
=*Andropogon monticola* Schult.	Katraj, Pune
Dichanthium annulatum Stapf.	Kirkee to Pune
=*Andropogon annulatus* Forssk.	Purandar, Chatushringi, Ganeshkhind, Panchgani.
D. caricosum A. Camus	Junnar, Shevgaon (Dist. A'nagar)
=*Andropogon caricosus* Linn.	Lohagad, Purandar
=*Andropogon contertus* Linn.	Pune, Kalas
Heteropogon insignis Thw.	Pune, Kalas near Lonavala, Chatushringi, Mawal.
=*Andropogon triticous* R. Br.	
H. ritchiei Blatter and McCann	Katraj, hills near Pune
=*Anthistiria cymbaria* Roxb.	
Themeda quadrivalvis O. Ktze.	Pashan, Purandar
=*Anthistiria ciliata* Linn. f.	Bhairawadi, Pune
T. tremula Hack	Pune, Purandar near foot of hill
T. triandra Forssk	Ganeshkhind, Bhairawadi near Purandar.
Iseilema anthophoroides Hack.	Katraj
I. prostratum Anderss	Kalas near Lonavala
=*I. wightii* Andress	Pune
Eremopogon foveolatus Stapf.	Kalas near Lonavala
=*I. wightii* Anders.	
=*Andropogon foveolatus* Del.	Law College hill
Andropogon pumilus Roxb.	Pune, Pashan, Bhairawadi near Purandar
Cymbopogon citratus Stapf.	Kalas near Lonavala
C. martinii Stapf.	Pashan, Purandar, Ganeshkhind
Paspalum pseudanthistiria heteroclita Hook. f.	Pune
P. hispida Hook. f.	Purandar
Digitaria marginata Link.	Law College hill, Pune
—*Paspalum sanguinale* Lamk. var. *ciliare*.	Law College hill, Pune
var. *fimbriata* Stapf.	
D. pedicellaris Prain	
—*Paspalum pedicellare* Trin.	Chatushringi
D. royleana Prain	Purandar, Katraj
D. sanguinalis Scop.	Chatushringi
Alloteropsis cimicina Stapf.	Sinhagad

Brachiaria isachne (Griseb.) Stapf.	Bhamburda Kalas near Lonavala Purandar
B. ramosa Stapf.	
—*Panicum ramosum* Linn.	Law College hill, Pune
B. mutica Stapf.	Cultivated at Kirkee
Paspalidium flavidum A. Camus.	Pune, Kirkee
P. geminatum Stapf.	Buna Garden, Pune
P. punctatum A. Camus.	Pune
Urochloa helopus Stapf.	Katraj, Ganeshkhind, Chatushringi.
Urochloa panicoides Beauv.	Kalas near Lonavala
–*Panicum javanious* Bl.	
U. reptans Stapf.	Kirkee, Pune
U. setigera Stapf.	Ganeshkhind
Echinochloa colona Link.	Purandar at the foot Nira canal, Kalas near Lonavala.
E. crus-galli Beauv.	
—*Panicum crusgalli* Linn.	Law College hill
Panicum montanum Roxb.	Half way up Lohagad
P. obscurans Woodrow	Manjri farm, near Pune
P. paludosum Roxb.	Pune
P. trypheron Schult.	Chatushringi, Law College hill
Setaria intermedia R. and S.	Purandar, Chatushringi, Law College hill
S. italica Beauv.	Ganeshkhind
S. pallidifusca Stapf. ex Hubbard	Shivapur near Pune
Rhyncholvtrum repens (Willd.) hubbard.	Kalas near Lonavala
—*Tricholaena* Nees.	
Pennisetum hoenackeri Hochst exssteu.l.	
—*P. bediceliatum* Trin.	Agriculture College farm. Pune
P. purpureum Schumm and Thom.	Pune
—*P. typhoideum* Rich.	
Cenchrus ciliaris Linn.	Kalas near Lonavala
—*Pennisetum cenchroides* Rich.	
C. setigerus Vahl.	Ganeshkhind
—*C. biflorus* Roxb.	Law College hill, Pune
Isachne australis R. Br.	Pune
Arundinella holcoides Trin.	Law College hill, Pune
—*A. agrostoides* Trin.	
—*A. brazilliensis* Raddi.	
—*A. avenacea* Munro.	
Thysanolaena precumbens Mez.	Ganeshkhind
Aristida adscencionis Linn.	Pashan.
—*A. depressa* Rets.	Law College hill, Pune
A. funiculata Trin. and Rupr.	Pashan, Kirkee, Katraj, Kalas near Lonavala.
Aristida hystrix L.	Ganeshkhind
A. redacta Stapf.	Junnar, Lohagad, Pashan, Law College hill, Pune.
A. setacea Retz.	Ganeshkhind
Tragus biflorus Schult.	Chatushringi.
T. racemosus Stapf.	

Nazia racemosa Kuntze	Pune, Chatushringi
Sporobolus diander Beauv. ..	Katraj, Chatushringi
S. coromandelianus Link. ..	Poona Agriculture College farm
S. indicus R. Br.	Chatushringi.
Eragrostis bifaria Wt.	Chatushringi, Law College hill
E. ciliancnsis (All.) Link. ..	Kalas at Lonavala
E. major Hochst.	Purandar, Kirkee, Pune Agri. College farm.
E. gangetica Steud.	Pune Mawal.
E. interrupta Beauv.	Bawdhan near Pune, Ganeshkhind, Bhairawadi near Purandar.
E. minor Host.	Purandar, Bhimthadi, Chatushringi.
E. nutans (Retz.) Nees	Pashan, Purandar
E. pilosa Beauv.	Waghoti near Mawal, Bhirawadi near Purandar, Chatushringi.
E. viscosa Trin.	Chatushringi.
=*E. tenella* R. and S.	Kalas near Lonavala
E. plumosa Stapf.	Pune
Oropetium thomacum Trin. ..	Sinhagad forest, Kalas near Lonavala, Law College hill, Pune.
Melanocenchris royleana Nees. ..	Katraj, Sinhagad
Cynodon dactylon Pers.	Purandar, Kalas near Lonavala
C. virgata Sw.	Manjri near Pune, Katraj, Bhamburda.
C. gayana Kunth.	Cultivated in Pune
Eleusine coracana Gaertn. ..	Cultivated in Pune
E. flagellifera Nees	Pune
E. indica Gaertn.	Chatushringi, Law College hill, Pune.
Dactyloctenium aegyptium Beauv.	
=*Eleusine aegyptiaca* Desf. ..	Bopodi
Dinebra retroflexa Psch. ..	Deolali, Dhond
=*D. arabica* Jacq.	Kalas near Lonavala, Agri. College farm.
Tripogon capillatus Jaub and Pach.	About Pune
Tripogon jacquemontii Stapf. ..	Pune Agri. College, Kirkee, Purandar, Kalas near Lonavala.
T. lisboae Stapf.	Purandar, Sinhagad
T. roxburghianus Bhide	Chatushringi, Kalas near Lonavala, Law College hill, Pune.
Hygrorhiza aristata Nees ..	Poona Agri. College garden
Elytrophorus spicatus A. Camus	Law College hill, Pune
=*E. articulatus* Beauv.	
Oryza sativa L.	Cultivated in Mawal
Triticum vulgare L.	
T. vulgaris Schard.	Pune, Satara, Kolhapur
Oxytenanthera ritchiei Blatter and Mc Cann.	Pune district
Dendrocalamus strictus Nees ..	Ganeshkhind.

Cyperaceae :

Kyllinga brevifolia Rottb. ..	Pune
K. triceps Rottb.	Chatushringi, Kalas near Lonavala
Pycreus flavescens Nees	Purandar, Mawal
P. globosus Reichb.	Riverside Pune, Manjri near Pune, Ganeshkhind.

P. nitens Nees	Panchgani
P. pumilus Dom.	Bhusi near Mawal
P. sanguinolentus Nees	In bed of water courses, Talegaon
Juncellus laevigatus Clarke ..	Nira canal
J. michelianus (Linn.) Blatter and Mc Cann.	Bhairwadi near Purandar, Katraj tank.
Cyperus aristatus Rottb. ..	Purandar fort, Talegaon, Parwati, Pune, Kirkee, Khed.
C. bulbosus Vahl.	Kirkee
C. compressus Linn.	Agri. College garden, Pune
C. corymbosus Rottb.	Pune, Kirkee
C. digitatus Roxb.	Ganeshkhind, Pune, Bopodi, Chinchwad.
C. eleusinoides Kunth.	Along water courses, Talegaon, Ganeshkhind, Bopodi.
C. iria Linn.	Purandar, Bhairwadi, Shivapur, Shivaneri fort.
C. teneriffae Poir.	Pune, Chatushringi, Junnar
C. rotundus Linn.	Purandar, Agriculture College farm, Kirkee, Parwati tank, Kalas near Lonavala.
Mariscus konkanensis Sedgwick ..	Purandar fort, Sinhagad
Eleocharis capitata R. Br. ..	Riverside Pune, Manjri near Pune, Nira Canal, Chinchwad.
E. fistulosa Link.	Panchgani Table-land
Fimbristylis aestivalis Vahl. var. *diphylla* Kukenth.	Mawal, Ganeshkhind,
F. complanata Link.	Chatushringi.
F. miliacea Vahl.	Panchgani
F. monostachya Hassk.	Chatushringi.
F. tetragona R. Br.	Mawal
F. woodrowii Clarke	Kalas near Lonavala.
Bulbostylis capillaris Kunth var. *trifida* Clarke.	Purandar.
Scirpus quinquefarius Ham. ..	Pune
S. supinus Linn.	Panchgani, Bhairwadi near Purandar.
Fuirena wallichiana Kunth. ..	Pashan, Pune
Rhychospora wightiana Steud. ..	Pune
Scleria stocksiana Boek.	Talegaon
Eriophorum comosum Wall. var. *major* Fischer.	Shivaneri fort, Junnar.

Palmae :

Phoenix sylvestris (Linn.) Roxb.	Sinhagad, Shirur, Yeravda, Katraj.
Caryota urens L.	Katraj

Araceae :

Pistia stratiotes Linn.	Yeravda
Cryptocoryne retrospiralise Roxb.	Ganeshkhind
=*C. spiralis* Fischer ex Wydler.	Pune
Typhonium amboinenso (Rumph) Blatter and Mc Cann.	
Colocasia esculenta (Linn.) Schott.	Sinhagad
=*Arum esculentum* L.	Torna
=*Colocasia antiquorum* Schott.	
Remusatia vivipara Schott. ..	Lohagad, Purandar, Torna

Amorphophallus commutatus Engl.	Ganeshkhind
Sauromatum guttatum (Wall.) Schott.	Junnar, Panchgani
Commelinaceae :	
Commelina forskalei Vahl.	Kalas near Lonavala
Murdannia semiteres (Dalz.) =*Ancilema scniteres* Dalz.	Sinhagad
C. fasciculata Schult.	Kalas near Lonavala, Chatushringi, Law College hill.
C. glabrescens Clarke	Sinhagad, Pune
C. tuberosa Schult.	Kalas near Lonavala, Chatushringi
Liliaceae :	
Asparagus racemosus L.	Kalas near Lonavala, Law College hill, Vetal hill.
Gloriosa superba Linn.	Torna
Asphodelus tenuifolius Cav.	Kalas near Lonavala
Chlorophytum laxum R. Br.	Law College hill
Chlorophytum orchidastrum Lindl.	Range hill, Ganeshkhind, Pune
C. tuberosum Enker	Kalas near Lonavala, Law College hill, Pune, Katraj.
Urginea indica Kunth.	Law College hill
Scilla indica Baker.	Law College nill, Kalas near Lonavala, Katraj.
Iphigenia indica Kunth.	Vetal hill, Law College hill, Chatushringi.
Dipcadi montanum Dalz.	Sirur, Chatushringi
Amaryllidaceae :	
Agave vivipara Wt.	
Curculigo orchioides Gaertn.	Panchgani, Torna
Dioscoreaceae :	
Dioscorea alata L.	Torna
D. bulbifera	Torna
D. hispida Dennst. =*D. daemona* Roxb.	Sinhagad
D. oppositifolia L.	Sinhagad, Torna
D. wallichii Hook f.	Sinhagad
Musaceae :	
Ensete superbum (Roxb.) Checseman. =*Musa superba* Roxb.	Sinhagad
Zingiberaceae :	
Curcuma decipiens Dalz.	Torna
Zingiber macrostachyum Dalz.	Sinhagad
Costus speciosus Sm.	Foot of Visapur
Cannaceae :	
Canna indica Linn.	Ganeshkhind
Orchidaceae :	
Dendrobium barbatum Lindl.	Sinhagad
Zeuxine strateumatica Schlecht.	Pashan.

Eulophia pratensis Lindl.	Pune, canal side, Pashan
Habenaria affinis Wt.	Purandar
H. commelinifolia Wall.	Purandar
H. crassifolia A. Rich.	Purandar, Panchgani
H. digitata Lindl.	Purandar
H. foliosa A. Rich.	Hills about Khadakvasla
H. grandiflora Lindl.	Mawal, Shivapur, Purandar
H. lengicalcarata A. Rich.	Purandar, Katraj ghat
H. marginata Colebr.	Junnar, Purandar
H. rariflora A. Rich.	Khandala, Lonavala, Karkala near Pune, Purandar.

Moraceae :

Trema orientalis Bl.	Parwati, Sinhagad
Ficus arnottiana Miq.	Sinhagad
F. bengalensis L.	Malavli to Bhaja, on way to Lohagad.
F. glomerata Roxb.	Malavli to Bhaja, Panchgani
F. religiosa L.	Yeravda, Vetal hill, Katraj ghat.
F. mysorensis Heyne	Sinhagad
F. retusa L.	Malavli to Bhaja, Sinhagad
Artocarpus integra (L.) Merr.	Torna
A. lakoocha Roxb.	Torna

Urticaceae :

Girardinia zeylanica Decne.	Sinhagad, Torna, Lohagad
Lecanthus peduncularia (Wall) Wedd. =*L. wallichii* Weed. =*L. wightii* Wedd. =*Procris peduncularis* Wall.	Sinhagad
Boehmeria scabrella Goud.	Malavli to Bhaja

Proteaceae :

Grevillea robusta Cunn.	Sinhagad

Santalaceae :

Osyris wightiana Wall =*O. arborea* Wall.	Katraj hills
Santalum album Linn.	Bhamburda, Torna, Law College hill, Vetal hill.

Loranthaceae :

Loranthus longiflorus Desf. =*Dendrophthoe falcata* Ettingh.	Law College hill, Pune
L. semrrula L.	
Taxillus cuneatus (Roth.) Denser =*Loranthus cuneatus* Roth	Sinhagad
Viscum album Linn.	Sinhagad, Katraj
V. angulatum Heyne ex DC.	Sinhagad, Katraj
V. articulatum Burm.	Law College hill, Pune

Aristolochiaceae :

Aristolochia bracteata Retz.	Deccan in fields of Jowar

Polygonaceae :

Polygonum glabrum Willd.	Sinhagad
P. plebejum R. Br. var. *indica* Hook. f.	Rajgad, Sinhagad
P. serrulatum Cooke	Sangam bridge, Pune

Chenopodiaceae :	
Chenopodium ambrosioides Linn.	A weed in Poona gardens, Yeravda.
Amaranthaceae :	
Celosia argentea Linn.	Sinhagad, Malavli to Bhaja, Lohagad, Kalas near Lonavala.
Digera arvensis Forssk.	Kalas near Lonavala, Law College hill, Pune, Yeravda.
Amaranthus spinosus L.	Malavli to Bhaja, Law College hill, Pune, Torna, Yeravda.
A. viridis L.	Sangam bridge, Pune
Pupalia atropurpurea Moq. ..	Law College hill, Pune
Achyranthes aspera L.	Pune, Malavli to Bhaja, Torna, Law College hill, Pune.
Aerua javanica Juss.	Deccan, not common
A. lanata Juss.	Chatushringi, Law College hill, Pune.
A. scandens (Roxb.) Wall. ..	Sinhagad
Alternanthera sessilis (Linn.) R. Br.	Sinhagad.
=*A. triandra* Lam.	Sangam bridge, Pune Law College hill, Pune, Yeravda
Gomphrena celosioides Mart. ..	Yeravda
Nyctaginaceae :	
Boerhaavia diffusa L.	Law College hill, Pune
=*B. repens* L.	Sirur, Kalas near Lonavala, Yeravda.
Phytolaccaceae :	
Phytolacca barbata Stapf. ..	Kalas near Lonavala
Portulacaceae :	
Portulaca oleracea L.	Malavli to Bhaja, Torna, Kalas near Lonavala, Law College hill,
=*Talinum cuneifolium* Walld.	Sinhagad.
Aizoaceae :	
Mollugo ergianum Thunb. ..	Sinhagad
M. pentaphylla L.	Malavli to Bhaja, Torna, Law hill, Pune.
Trianthema pentandra L. ..	Babhulgaon
Caryophyllaceae :	
Polycarpaea corymbosa Lam. ..	Kalas near Lonavala, Chatushringi
Dianthus caryophyllus Linn. ..	Cultivated in Mahabaleshwar
Ranunculaceae :	
Clematis gouriana Roxb. ..	Talegaon, Chinchwad
C. hedysarifolia DC.	Sinhagad
C. triolba Heyne	Sinhagad, Lohagad
Menispermaceae :	
Tinospora cordifolia (Willd) Miers	Lohagad, Sinhagad, Pune
Tiliacora acuminata Miers ..	Pune
Cocculus hirsutus Diels	Sinhagad
=*C. villosus* DC.	Law College hill, Pune, Katraj
Stephantea hernandifolia Walp. ..	Hills near Junnar, Malavli to Bhaja.

Cissampelos pariera Linn.	Sinhagad
Cyclea burmanni Miers	Pune, Lohagad
C. fissicalyx Dunn.	Torna, Katraj
=*C. peltata* Cooke	Lohagad
Magnoliaceae :	
Michelia champaca L.	Cultivated in Pune
Anonaceae :	
Anona squamosa L.	Parwati, Vetal hill, Katraj
Artabotrys odoratissimus R. Br.	Torna, Panchgani (Cultivated)
Lauraceae :	
Actinodaphne hookeri Meissn.	Foot of Visapur, Torna, Rajgad
Papaveraceae :	
Argemone mexicana L.	Weed at Katraj, Sinhagad, Malavli to Bhaja, Torna, Lohagad, Kalas near Lonavala, Yeravda.
Capparidaceae :	
Gynandropsis pentaphylla DC.	Pune, Panchgani
Cleome chelidonii Linn. f.	Between Pune and Karla
C. simplicifolia Hook. f. and Th.	Pune, Kalas near Lonavala, Chatushringi.
C. monophylla L.	Law College hill, Pune
C. viscosa L.	Deccan dry lands, Law College hill, Pune.
Maerua arenaria Hook. f. and Th.	Pune
Cadaba indica Lam.	Deccan dry lands
Capparis aphylla Roth	Deccan dry lands
C. dicidum Pax	Pune
C. divaricata Lam.	Deccan dry lands, Law College hill, Pune.
C. grandis Linn.	Bhuleshwar hill, Parwati, Katraj
C. zeylanica Linn.	Pune
=*C. horrida* Linn. f.	Ganeshkhind, Katraj
C. subumbellata Hook. f.	Torna, Lohagad
Brassica nigra Koch.	Torna, Yeravda
Moringaceae :	
Moringa oleifera Lamk.	Sinhagad, Pashan, Katraj
Crassulaceae :	
Bryophyllum pinnatum (Lamk.) Kurz.	Sinhagad, Panchgani
=*B. calycinum* Salisb.	Torna
Kalanchoe olivacea Dalz.	Sinhagad, Torna
Rosaceae :	
Fragaria vesca L.	Cultivated at Panchgani
Prunus communis L.	Panchgani
P. persica Stocks	Panchgani cultivated
Pyrus malus L.	Do.
Rosa multiflora Thunb.	Do.
Rubus lasiocarpus Sm.	Do.
Leguminosae : Mimosoideae	
Prosopis spicigera L.	Sirur

Acacia arabica Willd.	Kalas, Pune near Lonavala, Chatushringi, Talegaon, Katraj.
A. catechu Willd.	Pune, Katraj
A. concinna DC.	Katraj
A. ferruginea Lamk.	Law College hill, Pune
A. intsia (Linn.) Willd.	Sinhagad
A. leucophloea Willd.	Chatushringi, Law College hill, Pune, Parwati, Vetal hill.
A. melanoxylon R. Br.	Katraj
Albizzia lebbek Benth.	Law College hill, Pune
Cicer arietinum L.	Sinhagad

Caesalpinioideae :

Caesalpinia pulcherrima Sw.	Cultivated in Pune
Delonix regia Raf. =*Poinciana regia* L.	Yeravda, Vetal hill
Parkinsonia aculeata L.	Sirur
Cassia auriculata L.	Deccan dry lands, Law College hill, Pune.
C. fistula Linn.	Sinhagad, Katraj, Panchgani
C. kleinii W. and A.	Kalas near Lonavala
C. marginata Roxb.	Vetal hill
C. mimosoides L.	Ganeshkhind
C. occidentalis Linn.	Ganeshkhind
C. pumila Lamk.	Sinhagad, Torna, Ganeshkhind
C. siamea Lam.	Katraj
C. tora Linn.	Malavli to Bhaja, Torna, Chatushringi, Law College hill, Pune.
Bauhinia tomentosa L.	Ganeshkhind, Bhamburda
Tamarindus indica L.	Near Lohagad village
Hardwickia binata Roxb.	Law College hill, Pune

Papillioneae .

Heylandia latebrosa DC.	Torna, Kalas near Lonavala, Chatushringi.
Crotalaria albida Heyne ex Roth.	Sinhagad
C. calycina Schrank.	Sinhagad
C. filipes Benth	Malavli to Bhaja, Torna, Kalas near Lonavala.
C. juncea Linn.	Sinhagad, Kalas near Lonavala, Yeravda.
C. linifolia Linn. f.	Law College hill, Pune
C. medicaginea Lamk.	Sinhagad
C. mysorensis Roth.	Law College hill, Pune
C. nana Burm.	Sinhagad
C. orixensis Rottl.	Ganeshkhind
C. triquetra Dalz.	Sinhagad
Indigofera cordifolia Heyne ex Roth.	Law College hill, Pune, Chatushringi.
Indigofera endecaphylla Jacq.	Sinhagad.
I. glandulosa Willd.	Ganeshkhind, Kalas near Lonavala, Sinhagad.
I. linifolia Retz.	Ganeshkhind, Kalas near Lonavala, Law College hill, Pune.
I. pulchella Roxb.	Torna
I. trifoliata Linn.	Kalas near Lonavala
Psoralea corylifolia Linn.	Kalas near Lonavala, Ganeshkhind.

Tephrosia purpurea Pers. ..	Ganeshkhind, Belapur in Ahmednagar district, Kalas near Lonavala.
T. tenuis Wall.	Kalas near Lonavala, Law College hill, Pune.
Sesbania aculeata Poir.	Ganeshkhind, Kalas near Lonavala,
S. aegyptiaca Poir	Yeravda
Geissaspis cristata W. E. A. ..	Malavli to Bhaja
Zornia diphylla Pers.	Chatushringi, Kalas near Lonavala, Torna, Law College hill, Pune.
Taverniera nummularis Baker ..	Law College hill, Pune.
Smithia blanda Baker	Torna
S. hirsuta Dalz.	Do.
S. purpurea Hook.	Torna, Malavli to Bhaja, Sinhagad.
S. setulosa Dalz.	Torna, Sinhagad
Aeschynomene indica L. ..	Law College hill, Pune.
Alysicarpus belgaumensis Wt. ..	Torna
A. longifolius W. and A.	Ganeshkhind
A. monilifer DC.	Kalas near Lonavala, Law College hill. Pune.
A. pubescens Law	Ganeshkhind, Law College hill, Pune.
A. rugosus DC.	Kalas near Lonavala, Ganeshkhind
A. tetragonolabus Edgew. ..	Sinhagad, Chatushringi, Law College hill, Pune.
A. vaginalis DC.	Malavli to Bhaja, Torna, Pashan, Law College hill, Pune.
A. nummularifolius Baker ..	Panchgani.
Desmodium diffusum DC. ..	Law College hill, Pune.
D. rotundifolium Baker	Sinhagad
D. triflorum (L.) DC.	Bhaja to base of Lohagad, Torna, Malavli to Bhaja, Sinhagad.
D. triquetrum DC.	Panchgani
Abrus precatorius Linn. ..	Katraj, Chatushringi, Law College hill, Pune.
Terammus labialis Spr. ..	Malavli to Bhaja, Law College hill, Pune.
Erythrina indica Lamk. ..	Do.
E. stricta Roxb.	Sinhagad
Mucuna prurita Hook .. .. =*M. pruriens* Cooke.	Do.
Butea monosperma O. Ktze. .. =*B. forndosa* Koening ex Roxb.	Do.
Canavalia gladiata DC. =*C. ensiformis* Baker	Do.
Phaseolus khandalensis Santapau =*P. grandis* Dalz.	Do.
P. trilobus Ait.	Kalas near Lonavala, Ganeshkhind, Chatushringi.
P. radiatus Linn.	Sinhagad, Torna
=*P. sublobatus* Roxb.	Law College hill, Pune
Dolichos biflorus Linn.	Sinhagad
Atylosia scambaeoides (Linn.) Benth.	Sinhagad, Law College hill, Pune
A. sericea Benth	Torna
Rhynchosia bracteata Benth. ..	Sinhagad

R. minima DC.	Ganeshkhind, Kalas near Lonavala, Chatushringi.
Dalbergia lanceolaria Linn. f. ..	Sinhagad
D. latifolia Roxb.	Sinhagad, Law College hill, Pune
D. sissoo Roxb.	Law College hill, Pune
Pongamia glabra Venth. ..	Malavli to Bhaja, Parwati, Pashan Katraj.
Oxalidaceae :	
Oxalis corniculata L.	Sinhagad, Torna, Lohagad, Katraj, Law College hill, Pune.
Oxalis latifolia H. B. K. ..	Naturalised at Panchgani
O. tetraphylla Cav.	Naturalised at Panchgani
Biophytum sensitivum (Linn) DC.	Ganeshkhind, Chatushringi, Sinhagad.
Monsonia senegalensis G. and P.	Kalas near Lonavala
Linaceae :	
Linum mysorense Heyne	Foot of Torna fort, Sinhagad
Reinwardtia trigyna Planch. ex Hook.	Malavli
Zygophyllaceae :	
Fagonia cretica L.	Newasa in Ahmednagar
Guaiacum officinale Linn. ..	Ganeshkhind
Tribulus terrestris Linn. ..	Law College hill, Pune
Rutaceae :	
Murraya koenigii Spr.	Bhor
Atalantia monophylla DC. ..	Junnar, Panchagni
Feronia limonia (Linn.) Swingle .. =*F. elephantum* Corr.	Pune, Sinhagad
Simarubaceae :	
Balanites roxburghii Planch ..	Between Shevgaon and Pathardi (district Ahmednagar).
Ailanthus excelsa Roxb. ..	Law College hill, Pune, Shirur
Burseraceae :	
Boswellia serrata Roxb. ..	Chatushringi, Bhamburda, Sinhagad, Vetal hill
Garuga pinnata Roxb. ..	Sinhagad, Law College hill, Pune
Meliaceae :	
Turraea villosa Benn.	Rajgad
Cipadessa baccifera (Roth) Mig.	Sinhagad
=*C. fruticosa* Bl.	Torna, Katraj, Parwati
Azadirachta indica A. Juss. ..	Sirur, Bhamburda, Kalas near Lonavala, Yavat, Katraj.
Heynea trijuga Roxb.	Katraj
Malpighiaceae :	
Aspidopterys cordata (Heyne) ...	Sinhagad
Hiptage bengalensis (Linn.) Kurz.	Panchgani, Pune (cultivated)
Polygalaceae :	
Polygala chinensis L. — —	Kalas near Lonavala, Ganeshkhind, Chatushringi.

P. elongata Klein	Law College hill
P. erioptera DC.	Pune, Panchgani, Kalas near Lonavala, Chatushringi, Sirur.
P. persicariaefolia DC.	Sinhagad

Euphorbiaceae :

Euphorbia antiquorum Linn. ..	Malavli to Bhaja, Sinhagad
E. coccina Roth.	Kalas near Lonavala
E. elegans Spreng.	Torna, Law College hill, Pune
E. geniculata Ort.	Ganeshkhind, Law College hill, Pune, Kalas near Lonavala.
E. hirta L.	Sangam bridge, Ganeshkhind
=*E. pilulifera* L.	Chatushringi, Kalas near Lonavala, Torna, Sinhagad, Yeravda, Katraj.
E. hypericifolia L.	Ganeshkhind, Kalas near Lonavala, Chatushringi.
E. reriifolia Linn.	Talegaon, Sinhagad
=*E. ligularia* Cooke	Torna
E. rothiana Spr.	Torna, Malavli to Bhaja, Katraj
E. tirucalli L.	Vetal hill (Pune), Malavli to Bhaja, Katraj, Torna.
Pedilanthus tithymaloides Poit ..	Malavli to Bhaja, Katraj, Torna
Bridelia retusa Spr.	Hills of Deccan, Sinhagad, Panchgani.
B. squamosa Gehrm.	Rajgad, Sinhagad, Torna
Phyllanthus maderaspatensis L.	Kalas near Lonavala, Chatushringi, Ganeshkhind, Law College hill, Pune.
P. niruri L.	Law College hill, Pune, Lohagad
Emblica officinalis Gaertn. ..	Sinhagad, Torna
=*Phyllanthus emblica* Linn.	
Fluggea leucopyrus Willd. ..	Chatushringi, Talegaon, Law College hill, Pune, Katraj.
F. microcarpa Bl.	Torna, Kalas near Lonavala
Securinega virosa (Roth) Pax and Hoffm.	Sinhagad
Phyllanthus virosa Roxb.	
Melanthosa turbianata Wt. ..	Sinhagad
Breynia patense Koen ex Roxb.	
Putranjiva roxburghii Wall. ..	Ganeshkhind
Chrozophora prostrata Dalz. ..	Talegaon
C. rottleri Kletsch.	Yeravda
Acalypha brachystachya Hornem.	Sinhagad
A. malabarica M. Arg. ..	Ganeshkhind, Law College hill, Pune, Kalas near Lonavala.
A. wilkesiana M. Arg.	Ganeshkhind
Homonoia riparia Lour. ..	Vetal wadi
Ricinus communis L.	Near Torna village, Bhaja village, Sinhagad, Yeravda.
Jatropha curcas L.	Sinhagad, Vetal hill, Chatushringi Lohagad, Torna, Pashan
J. glandulifera Roxb.	Law College hill, Pune
J. nana Dalz.	Law College hill, Pune, Katraj
Tragia cannabina L.	Belapur
T. involucrata Linn.	Foot of Visapur

Anacardiaceae :

Buchanania lanzan Spr.	Law College hill, Pune

Mangifera indica L.	Sinhagad, Malavli to Bhaja, Torna, Sirur, Katraj.
Semecarpus anacardium Linn. f.	Sinhagad, Pune
Odina woodier Roxb.	Bhamburda, Katraj ghat, Chatushringi.
Rhus mysurensis Heyne	Bhamburda, Law College hill, Katraj.
Celastraceae :	
Celastrus paniculata Willd. ..	Parwati, Sinhagad, Katraj
Gymnosporia montana (Roxb) Bentn.	Sinhagad, Bhamburda, Chatushringi, Katraj hill.
G. rothiana Laws	Talegaon
Elaeodendron glaucum Pers. ..	Chatushringi, Law College hill
Salvadoraceae :	
Salvadora oleoides Decne. ..	Sirur
Sapindaceae :	
Cardiospermum halicacabum Linn.	Chatushringi, Ganeshkhind
Allophylus cobbe Bl.	Malavli to Bhaja, Torna, Rajgad, Lohagad.
Dodonea viscosa L.	Ganeshkhind, Katraj
Balsaminaceae :	
Impatiens balsamina Linn. var. *agrestis* Hook.	Torna
I. balsamina Linn. var. *resea* Hook.	Torna
=*I. balsamina* Linn. var. *brevicalcarata*.	Malavli to Bhaja
I. dalzelli Hook. f. and Th. ..	Purandar
Rhamnaceae :	
Zizyphus jujuba Lamk.	Vetal hill, Chatushringi, Kalas near Lonavala, Torna, Sinhagad, Katraj.
Zizyphus oenoplea Mill. ..	Chatushringi, Kalas near Lonavala, Torna, Sinhagad, Katraj.
Z. rugosa Willd.	Torna, Sinhagad, Panchgani
Z. xylopora Willd.	Belapur, Chatushringi, Bhamburda.
Vitaceae :	
Vitis elongata Wall.	Rajgad
V. vinifera L.	Ganeshkhind
Cissus elongata Roxb.	Sinhagad
=*Vitis elongata* Wall.	Malavli to Bhaja
C. pallida Planch.	Deccan
=*Vitis pallida* W. and G.	
C. setosa Roxb.	Chatushringi
=*Vitis setosa* Wall.	Law College hill
C. woodrowii Santapau	Sinhagad, Vetal hill
=*Vitis woodrowii* Stapf. ..	Torna, Talegaon, Chatushringi
Cayraytia carnosa G. agnep. ..	Sinhagad
=*Vitis trifolia* Linn.	Ganeshkhind
Leea macrophylla Roxb. ..	Malavli to Bhaja
Tiliaceae :	
Grewia asiatica Linn.	Malavli to Bhaja, Chatushringi
G. obtusa Wall.	Law College hill

G. tiliaefolia Vahl.	.. ..	Sinhagad, Torna, Panchgani
Triumfetta pilosa Roth.	..	Malavli to Bhaja
T. rotundifolia Lamk.	..	Field borders in Sirur, Law College hill.
Corchorus antichorus Rauesch	..	Deccan, on poor soils
C. fascicularis Lamk.	.. ..	Law College hill
C. trilocularis Burm.	.. ..	Kalas near Lonavala, Ganeshkhind

Malvaceae :

Abutilon polyandrum W. and A.		Purandar, Panchgani
Gossypium hirsutum L.	..	Kalas near Lonavala
Malvastrum coromandelianum Garck.		Pune
Sida acuta Burm.	.. ..	Yeravda
S. grewioides Guill. and Perr.	..	Kalas near Lonavala
S. rhombifolia L. ..	.. ..	Torna
S. retusa Mast. ..	.. ..	Pune, Panchgani
S. rhomboides Mast.	.. ..	Sinhagad
S. spinosa Linn. ..	.. ..	Chatushringi
S. veronicaefolia Lamk. ..	..	Sinhagad, Torna
Urena lobata Linn.	.. ..	Torna, Malavli to Bhaja
Hibiscus cannabinus Linn.	..	Sinhagad
H. ficulneus L.	.. ..	Ganeshkhind
H. micranthus Linn. f.	.. ..	Kalas near Lonavala.
H. rosa-sinensis L.	.. ..	
Thespesia populnea L.	.. ..	Malavli to Bhaja

Bombacaceae :

Salmalia malabarica Schott. and Endl.		Torna
—*Bombax malabaricum* DC.	..	Malavli to Bhaja, Pune, Katraj

Sterculiaceae :

Pterygota alata R. Br.	.. ..	Planted at Pune
Guazuma tomentosa Kunth.	..	Ganeshkhind

Theaceae :

Camellia thea Link	— —	Cultivated near Panchgani

Elatinaceae :

Bergia odoratissima	— —	Valavana (Pune district)

Flacourtiaceae :

Casearia graveolens Dalz.	..	Mawal
C. tomentosa Roxb.		
Flacourtia latifolia T.	.. ..	Cooke.
Flacourtia ramontchi L. Heri	.. ..	Bhamburda, Rajgad, Vetal hill Law College hill.

Cochlospermaceae :

Cochlospermum gossypium DC.	..	Bhamburda, Chatushringi, Vetal hill, Law College hill.

Caricaceae :

Carica papaya L,,.	.. ..	Panchgani, Sinhgad, Torna, Pune
Begonia crenata Dryand ..	..	Torna, Panchgani, Lohagad

Cactaceae :

Opuntia elatior Haw.	.. ...	Kalas near Lonavala, Sinhagad
O. nigricans Haw ..	... ...	Talegaon

Thymelaeaceae :	
Lasiosiphon eriocephalus Decne. ..	At the foot of Lohagad, Malavli to Bhaja, Sinhagad.
Elaeagnaceae :	
Elaeagnus kologa Schlecht =*E. latifolia* ..	Malavli to Bhaja
Lythraceae :	
Rotala tenuis (Wt.) Koehne ..	Sinhagad
=*Ammannia tenuis* Clarke. ..	Vetalwadi
Ammania baccifera Linn. ..	Sinhagad, Malavli to Bhaja, Parwati.
Woodfordia fruticosa (L.) Kurz ..	Chatushringi
=*W. floribunda* Salisb	Lohagad, Torna, Malavli to Bhaja.
Lawsonia inermis L.	Malavli to Bhaja
Combretaceae :	
Terminalia arjuna W. and A. ..	Pune, Law College hill
T. chebula Retz.	Torna, Yeravda
T. crenulata Roth.	Sinhagad.
=*T. tomentosa* W. and A. ..	Rajgad
T. paniculata Roth.	Lohagad
T. tomentosa W. and A.	Bhamburda, Visapur, Torna
T. bellerica Roxb.	Bhor taluka
Anogeissus latifolia Wall. ..	Sinhagad, Chatushringi, Bhamburda.
Calycopteris floribunda Lamk. ..	Panchgani, Khandala
Myrtaceae :	
Psidium guyava Linn. ..	Sinhagad, Malavli to Bhaja, Parwati.
Syzygium cumini (Linn.) Skeels ..	
=*Eugenia jambolana* Lam. ..	Torna, Malavli to Bhaja
Myrtus communis Linn.	Sinhagad
Melastomaceae :	
Memecylon umbellatum Burm. ..	Bhimashankar
Oenotheraceae :	
Oenothera rosea Ait.	Sinhagad
Umbelliferae :	
Carum stictocarpum Clarke ..	Panchgani
Pimpinella adscendens Dalz. ..	Sinhagad
P. monoica Dalz.	Sinhagad, Malavli to Bhaja, Visapur.
P. multiradiata Santapau ..	Sinhagad
P. tomentosa Dalz.	Sinhagad, Panchgani
Trachyspermum stictocarpum (Clarke) var. *typica* Wolff. ..	Sinhagad
Primulaceae :	
Anagallis arvensis Linn. var. *caerrulea* Gren. and Godr.	Pune on wet garden soil, Torna, Sinhagad.
Plumbaginaceae :	
Plumbago zeylanica L.	Sinhagad, Panchgani

Sapotaceae :	
Mimusops elengii L.	Panchgani, cultivated in Pune
Ebenaceae :	
Diospyros melanoxylon Roxb. ..	Deccan
Symplocaceae :	
Symplocos beddomei Clarke ..	Panchgani, Khandala ghat
Oleaceae :	
Jasminum malabaricum Wt. var. *obovatum* Clarke	Lohagad, Torna, Malavli to Bhaja, Sinhagad, Parwati.
Nyctanthes arbor-tristis L. ..	Ganeshkhind
Schrebera swietenioides Roxb. ..	Chatushringi
Gentianaceae :	
Exacum bicolor Clarke	Pune, Pashan
E. pumilum Gris.	Pashan, Law College hill, Parwati, Yeravda.
Erythraea roxburghii Don. ..	Kalas near Lonavala, Torna
Canscora decurrens Dalz. ..	Kalas near Lonavala
Canscora diffusa R. Br.	Sinhagad, Panchgani, Torna, Malvali to Bhaja.
C. khandalensis Santapau ..	Sinhagad
Swertia decussata Nimmo ..	Torna, Panchgani
Apocynaceae :	
Carissa congesta Wt.	Sinhagad, Panchgani
=*C. carandas* L.	Malavli to Bhaja, Lohagad, Vetal hill, Chatushringi.
Plumeria acuminata Ait.	Sinhagad, Malavli
=*P. acutifolia* Poir.	Malavli to Bhaja, Lohagad, Vetal hill, Ganeshkhind.
Holarrhena antidysenterica Wall. ..	Panchgani, Sinhagad, Lohagad, Ganeshkhind, Vetal hill.
Wrightia tomentosa R. and S. ..	Ganeshkhind, Law College hill
Nerium indicum Mill.	Sinhagad, Torna
=*N. odorum* Ait.	Vetal hill
Vinca pusilla Murr.	Kalas near Lonavala
Asclepiadaceae :	
Hemidesmus indicus R. Br. ..	Purandar, Pune, Sinhagad, Malavli to Bhaja, Torna, Chatushringi.
Cryptolepis buchanani R. and S.	Near Pune, Sinhagad, Malavli to Bhaja, Torna, Lohagad, Katraj.
Cryptostegia grandiflora R. Br. ..	On way Pune to Wai, Malavli to Bhaja, Kalas near Lonavala.
Calotropis gigantea R. Br. ..	Panchgani, Chatushringi, Law College hill.
C. hirsuta W. and A.	Yeravda
Asclepias curassavica Linn. ..	Pune, Yeravda
Oxystelma esculentum R. Br. ..	Pune, river bank near Sangam
Holostemma annulare K. Schumm.	Kothrud near Pune, Bawdhan
Pergularia daemia Blatter and McCann.	Kalas near Lonavala, Pune
Sarcostemma acidum Voigt. ..	Pune, Chatushringi hill

=*S. brevistigma* W. and A. ..	Law College hill
S. intermedium Decne.	Katraj ghat
Gymnema sylvestris R. Br. ..	Panchgani and also in Deccan dry lands.
Tylophora dalzellii Hook... ..	Law College hill, base of Lohagad
Marsdenia volubilis T. Cook. ..	Pune, Law College hill, Katraj
M. angustifolia Hook. f.	Common at Pune
Oianthus deccanensis Talbot ..	Ghat west of Pune.
O. urceolatus Benth.	Pune.
Heterostemma dalzellii Hook. f.	Pune
Leptadenia reticulata W. and A.	Chatushringi, Belapur (Ahmednagar), Law College hill.
Ceropegia attenulata Hook. ..	Junnar
C. hirsuta Wt.	Law College hill
C. hispida Blatter and McCann.	Near Gadavli, Panchagani
C. lawii Hook.	Torna, Sinhagad
C. tuberosa Roxb.	Law College hill
Caralluma adscendens R. Br.	
C. attenuata	Bopodi near Pune
C. fimbriata Wall.	Chatushringi, Law College hill, Katraj.
Frerea indica Dalz.	Purandar
Dregea volubilis Benth.	Chatushringi, Vetal hill

Convolvulaceae :

Rivea hypocrateri formis Choisy ..	Law College hill, Katraj Chatushringi.
Argyreia cuneata Ker Gaw l. ..	Sinhagad, Katraj, Ganeshkhind, Law College hill, Pune.
A. setosa (Roxb.) Cnoisy ..	Sinhagad
Lettsomia setosa Roxb. ..	
Lettsomia elliptica Wt. ..	Malavli to Bhaja, Panchgani
Ipomoea hederacea Jacq ..	Ganeshkhind
I. nil Rotha	
=*I. hederacea* Auct.	Sinhagad
I. pes-tigridis L.	Kalas near Lonavala
I. soluta Kerr.	
=*I. companulata*	Sinhagad
Quamoclit phoenicea Choisy ..	Ganeshkhind
=*Ipomoea concinia* Clarke ..	
Q. pinnata	
=*Ipomoea quamoclit* Linn. ..	Ganeshkhind
Calonictyon muricatum G. Den. ..	Ganeshknind
=*Ipomoea muricata* Jacq. ..	..
Porana malabarica Clarke ..	Grown in gardens
Evolvulus alsenoides L.	Law College hill, Chatushringi, Torna.
Merremia emarginata Hall. f. ..	Ganeshkhind
=*Ipomoea reniforis* Choisy ..	
Boraginaceae	
Cordia dichotoma Forst f. ..	Sinhagad
=*C. obliqua* Willd.	
=*C. myxa* Auct.	
Ehretia aspera Willd.	Deccan hills, Chatushringi, Torna, Katraj.
Heliotropium ovalifolium Forssk	Kalas near Lonavala, Law College hill.
H. supinum L	Pune, Law College hill

H. tuberculosum Boiss.	Chatushringi, Pune Law College hill.
H. zeylanicum Lam.	Shevgaon (Ahmednagar)
Trichodesma amplexicaule Roth ..	Ganeshkhind, Torna, Sinhagad
T. indicum R. Br.	Law College hill, Ganeshkhind
Cynoglossum denticulatum DC. ..	Malavli to Bhaja
Paracaryum lambertianum Clarke	Torna

Verbenaceae :

Lantana camara Linn. var. *acaleata* Moldenke.	Ganeshkhind, Chatushringi, Kalas near Lonavla.
Lippea nodiflora Michx.	Vithalwadi, Kalas near Lonavala, Torna, Yeravda.
Callicarpa lanata L.	Katraj, Rajgad, Panchgani
Tectona grandis Linn. f.	Bhamburda, Sinhagad, Katraj, Vetal hill.
Clerodendron inerme Gaertn. ..	Katraj
C. phlomoides Linn. f.	Deccan
C. serratum (Linn.) Murr. ..	Sinhagad, Torna
Vitex negundo L.	Rajgad, Sinhagad, Sirui, Lohagad Torna, Katraj.
Duranta plumeri Jacq.	Ganeshkhind

Labiatae :

Ocimum americanum Linn. ..	Pashan, Katraj
=*O. cannum* Sims.	Chatushringi, Law College hill, Pune.
Orthosiphon pallidus Royle. ..	Chatushringi, Law College hill, Pune.
O. tomentosus Benth.	Kalas near Lonavala
Plectranthus coesta Buch Han. ..	Sinhagad
P. mollis (Ait.) Spr.	Panchgani, Sinhagad
=*P. incanus* Link.	Malavli to Bhaja
Lavandula bipinnata O. Ktze. ..	Ganeshkhind
=*L. burmanni* Benth.	Kalas near Lonavala, Law College hill.
L. perottetii Benth.	Torna, Sinhagad
Pogostemon parviflorus Benth. ..	Sinhagad, Malvali to Bhaja, Lohagad.
Dysophylla stellata Benth. ..	Sinhagad, Panchgani
Colebrookia oppositifolia Sm. ..	Sinhagad, Lohagad, Torna
Anisomeles ovata R. Br.	Sinhagad
Leucas aspera Spr.	Pune, Law College hill
L. biflora R. Br.	Mutha river, Vitthalwadi
L. lavandulaefolia Rees.	Sinhagad
=*L. linifolia* Spr.	
L. longifolia Benth.	Chatushringi, Kalas near Lonavala.
L. martinicensis (SW.) R. Br. ..	Sinhagad
L. montana Spr.	Sinhagad, Panchgani
L. stelligera Wall.	Lohagad, Torna, Malvali to Bhaja.
Leonotis neoaefolia R. Br. ..	Law College Hill, Pune
Nepeta hindustana (Roth) Haines	Sinhagad
=*N. ruderalis* Buch. Ham. ..	

Solanaceae :

S. indicum L.	Malvali to Bhaja, Sinhagad

S. nigrum L.	Mutha river, Torna, Sinhagad, Panchgani.
S. xanthocarpum Schard. and Wendl.	Talegaon, Yeravda
Physalis peruviana L.	Cultivated at Panchgani
Nicandra physalioides (Linn.) Gaertn.	Sinhagad, Ganeshkhind
Datura fastuosa L.	Ganeshkhind
D. stramonium L.	Yeravda

Scrophulariaceae :

Verbascum coromandelianum (Vahl.) ..	Sinhagad
=*Celsia coromandeliana* Vahl. Kuntze.	Torna, Vitthalwadi, Chatushringi
Kickria incana (Wall.) Penn. ..	Law College hill and Hostel
K. ramolissima (Wall.) Janchen ..	Chatushringi
=*Linaria ramocissima* Wall. ..	Katraj, Vetal hill
Lindernia indica (Linn.) O. Kuntze	Sinhagad
=*L. urticaefolia* Lehm.	
Lindernia hyssopoides (Linn.) Haines	
=*Ilysanthes hyssopioides* Benth.	
L. parviflora (Roxb.) Haines.	Sinhagad
=*I. parviflora* Benth.	
Veronica anagallis Linn. ..	Sinhagad, Rajgad
Buchnera hispida Buch. Ham. ..	Torna, Malavli to Bhaja, Sinhagad, Law College hill.
Striga densiflora Benth. ..	Chatushringi, Kalas near Lonavala
S. euphrasioides Benth. ..	Law College hill
S. gesneroides (Willd.) Vatke. ..	Chatushringi
=*S. orobanchoides* Benth. ..	Sinhagad
S. lutea Lour.	Chatushringi, Kalas near Lonavala, Torna.
Rhamphicarpa longifolia Benth. ..	Torna
Sopubia delphinifolia (Roxb.) G. Don.	Vitthalwadi, Chatushringi, Kalas
S. trifida Buch Ham.	Torna, Panchgani, Sinhagad

Bignoniaceae :

Oroxylum indicum Vent. ..	Ganeshkhind, Katraj
Millingtonia hortensis Linn. f. ..	Yeravda
Dolichandrone faleta Seen. ..	Chatushringi, Bhamburda, Law College hill.
Heterophragma quadrilocularis (Roxb.) Schum.	Malavli
=*H. roxburghii* DC.	Torna, Bhamburda, Chatushringi
Stereospermum tetragonum DC.	Bhamburda
=*S. chelonoides* Cl.	
Tecoma stans Juss.	Ganeshkhind, Vetal hill, Katraj

Martyniaceae :

Martynia annua L.	Pune, Katraj
=*Martynia diandra*	Sinhagad

Gesneriaceae :

Aeschynanthus perottetti A. DC.	Visapur

Acanthaceae :

Thumbergia alata Boj.	Visapur fort

Blepharis asperrima Nees ..	Torna, Malavli to Bhaja, Sinhagad.
B. molluginifolia Pers.	Law College hill
Asteracantha longifolia Pers. ..	Do.
Hygrophila serpyllum (Nees.) T. And.	Sinhagad, Torna
Ruellia patula Jacq.	Kalas near Lonavala, Law College hill.
R. tuberosa L.	Empress Garden, Pune
Hemigraphis latebrosa Nees var. *heyneana* Bremek.	Sinhagad, Torna, Malavli to Bhaja.
Calophanes dalzellii T. And. ..	Law College hill
Eranthemum roseum (Vahl.) R. Br. =*Daedalacanthus roseus* T. And.	Torna, Malavli to Bhaja, Sinhagad.
Andrographis echioides Nees ..	Law College hill, Kalas near Lonavala.
Carvia callosa (Wall.) Bremek.	Sinhagad, Torna, Lohagad
Strobilanthus ixiocephalus Benth.	Panchgani, Rajgad
Haplanthus tentaculatus Nees	
H. verticillaris (Roxb.) Nees ..	Sinhagad
Barleria cristata L.	Ganeshkhind
B. lawii T. And.	Torna, Sinhagad
Asystasia violacea Dalz.	
Lepidagathis cristata Willd. ..	Kalas near Lonavala, Vetal hill, Law College hill.
L. cuspidata (Wall.) Nees ..	Sinhagad
L. mitis Dalz.	Sinhagad
L. trinervis Nees var. *asperrima*.	Talegaon
Rungia parviflora Nees ..	Empress garden, Pune
Rungia pectincita (Linn.) Nees var. *pectinata* Clarke.	Sinhagad
R. repens (Linn.) Nees ..	Sinhagad, Law College hill
Justicia betonica Linn.	Torna
J. diffusa Willd.	Ganeshkhind, Kalas near Lonavala, Chatushringi
J. procumbens Linn.	Sinhagad, Panchgani
J. quinqueangularis Koen. ..	Kalas near Lonavala
J. simplex D. Don.	Torna, Pune Law College hill
Adhatoda vasica Nees	Sinhagad, Torna, Visapur
Peristrophe bicalyculata (Retz.)	Near Sinhagad
Rubiaceae :	
Mitragyna parvifolia Korth. ..	Sinhagad
Dentella repens Forst. ..	Vitthalwadi
Oldenlandia aspera DC. ..	Kalas near Lonavala, Ganeshkhind, Law College hill.
O. corymbosa L.	Chatushringi, Panchgani, Law College hill.
O. herbacea (Linn.) Roxb. ..	Sinhagad
Anotis foetida Benth and Hook. f.	Law College hill
A. montholoni Hook. f.	Kalas near Lonavala, Chatushringi, Ganeshkhind.
Randia brandisii Gamble .. =*R. tomentosa* W. and A. ..	Lohagad
R. dumetorum Lamk.	Chatushringi, Lohagad, Visapur Torna, Law College hill.
Gardenia turgida Roxb. ..	Vetal hill

Meynia laxiflora Robyns .. Sinhagad
=*Vangueria spinosa* Auct. .. Malavli to Bhaja
=*Xeromphis spinosa*
Ixora parviflora Vahl. .. .. Visapur
Hamiltonia suaveolens Roxb. .. Sinhagad, Torna
Morinda citrifolia Linn. .. .. Chatushringi
M. tinctoria Roxb. .. .. Chatushringi, Law College hill, Katraj.
M. tomentosa Hook. f. .. .. Newasa in District Ahmednagar
Borreria hispida K. Sch. .. Law College hill
=*Spermacoce hispida* Linn. ..
B. stricta K. Sch. .. .. Way to Lohagad
=*Sp. strictus* Linn. f. .. .. Torna, Chatushringi, Sinhagad, Kalas near Lonavala.
Rubia cordifolia L. .. .. Torna, Visapur

Cucurbitaceae :
Bryonopsis laciniosa Naud. .. Sinhagad
Cucumis callosus (Rottl) Cogn. .. Sinhagad
=*Bryonia callosa* Rottl.
Cucumis melo Linn. var. *agrestis* Naud. Sinhagad, Panchgani
C. trigonus Roxb. .. .. Balapur
Citrullus colocynthus Schard. Between Shevgaon and Babhulgaon (District Ahmednagar).
Coccinia indica W. and A. .. Kalas near Lonavala
Cucurbita maxima Linn. .. Visapur, Torna, Yeravda
Corallocarpus epigaeus Clarke .. Chatushringi

Campanulaceae :
Cephalostigma schimperi Hochst. Sinhagad
C. flexuosum Hook. f. and Th. .. Torna
Campanula alphonsoi Wall. .. Sinhagad
Lobelia heyneana R. and S. .. Sinhagad
=*L. trialata* Buch. Ham. ..
L. nicotianaefolia Heyne .. .. Torna, Visapur, Lohagad

Compositae :
Centratherum phyllotaenum (DC.) Benth. Sinhagad
C. tenue Clarke .. .. Sinhagad, Panchagni
Lamprachaenium microcephalum Benth. Sinhagad
Vernonia cinerea (Linn.) Less. Law College hostel, Kalas near Lonavala, Sinhagad
Adenostemma viscocum Forst. .. Panchgani
Ageratum conyzoides L. .. Panchgani, Sinhagad, Torna, Lohagad, Chatushringi.
Dichrocephala latifolia DC. .. Sinhagad
Cyathocline purpurea(Don.)O.Ktze.
=*C. lyrata* Cass. .. .. Sinhagad, Malavli to Bhaja, Torna, Parner (District Ahmednagar).
Conyza stricta Willd. .. .. Sinhagad, Panchgani, Torna, Malavli to Bhaja, Rajgad.
Blumea malcolmi (Clarke) Hook. f. Torna, Sinhagad, Panchgani
B. oxyodonta DC. .. .. Torna
B. wightiana DC. .. .. Sinhagad

Vicoa indica (Willd) DC. ..	Torna
=*V. auriculata* Cass.	Chatushringi, Pune, Kalas near Lonavala, Law College hill.
V. cernua Dalz.	Torna, Sinhagad
Pulicaria wightiana DC.	Chatushringi, Pune, Law College, hill, Kalas near Lonavala.
Caesulia axillaris Roxb. ..	Kalas near Lonavala, Pune, Law College hill, Chatushringi.
Xanthium strumarium L. ..	Yeravda, Law College hill, Pune
Lagasca mollis Cav.	Ganeshkhind, Sinhagad, Law College hill.
Acanthospermum hispidum Don.	Sinhagad, Law College hill
Siegesbeckia orientalis (Linn.) Hassk.	Malavli to Bhaja, Yeravda
Eclipta alba (Linn.) Hassk. ..	Malavli to Bhaja
=*E. erecta* Linn.	Yeravda
Blainvillea latifolia (Linn. f.) DC.	Sinhagad
=*B. rhomboidea* Cass. ..	Law College hill
Guizotia abyssinica Cass ..	Sinhagad, Malavli to Bhaja
Guizotia tinctoria Cass.	Torna
Glossocardia linearifolia Cass. ..	Kalas near Lonavala, Sinhagad Chatushringi hill.
Bidens biternata Merr. and Sheriff.	Torna
=*B. pilosa* Auct.	Torna, Malavli to Bhaja, Sinhagad, Law College hill.
Tridax procumbens L.	Katraj, Law College hill
Flaveria contrayerba Pers. ..	Ganeshkhind, Kalas near Lonavala, Deccan in poor soils. Sinhagad.
Artemisia nilagirica (Clarke) ..	Pamp.
=*A. vulgaris* L.	Sinhagad
Gynura angulosa DC.	Sinhagad, Panchgani
Emilia sonchifolia (L.) DC. ..	Torna, Malavli to Bhaja, Sinhagad.
Notonia grandiflora DC.	Katraj, Panchgani
Senecio edgeworthii Hook. f. ..	Torna, Sinhagad
S. gibsoni Hook. f.	Sinhagad
Echinops echinatus DC.	Ganeshkhind, Chatushringi, Torna, Law College hill.
Tricholepis amplexicaulis Clarke	Sinhagad
T. radicans DC.	Chatushringi, Kalas near Lonavala, Torna, Law College hill.
Carthamus tinctorius L. ..	Sangam bridge
Dicoma tomentosa Cass. ..	Law College hill
Lactuca runcinata DC.	Law College hill
Sonchus arvensis Linn.	Chatushringi, Law College hill
S. asper Hill	Sinhagad
S. arvens Linn.	Chatushringi, Law College hill
S. oleraceus Linn.	Sinhagad
Launaea nudicaulis Less. ..	Chatushringi, Kalas near Lonavala
Zinnia elegans Jacq.	Ganeshkhind

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0.5 Flora of Nasik District

5.1. *Topography, Climate and Soil* :

This is a dry district having undulating surface, except in Malegaon, Sinnar, Yeola and partly in Nandgaon and Niphad talukas. The latter are plain and lie in the basin of various rivers and streams. The larger rivers Godavari, Girna and Vaitarna rise from Sahyadris and flow through this district. The peak line of Sahyadris forms the water shade between Vaitarna and Darna river system.

Physiographically there are four major regions of the district :—

1. Konkan tract down the ghats and peaks.
2. Girna basin
3. Godavari basin, and
4. Surgana adjacent to Sahyadri ranges.

Agriculturally valleys through which the rivers flow are important as the major crops are grown there. Topography is rugged in regions close to Sahyadris. The soils are light. The rainfall in the four regions is different. It is heavy in regions next to Sahyadri ranges and decreases towards east. There is fairly good irrigation in the regions which are in plains, mainly in Girna basin. The soils here are light and reddish brown in many places, but they are alluvial where the big rivers like Godavari, Girna flow e.g. in Nasik, Malegaon, Niphad and Manmad. Yeola has black cotton soils. In Igatpuri and in ghat region the soil is light and gravelly.

The whole district is derived from Deccan traps. There is no lateritic soil on the summits of Sahyadri mountain here as in other places. This is rather unusual.

Climate.—It is generally dry and variable. The annual rainfall also is variable. The average annual rainfall for the whole district is 40.73" or 1034.5 mm. However in the region of the ghats and those in close proximity of Sahyadri, it is heavier e.g. in Peint in the north, it is 2351.6 mm (92.58"). At Igatpuri towards south it is 3341.6 mm (131.56"), at Dindori it is 753.1 mm and at Satana 477.3 mm. Igatpuri is the wettest part of the district. Variations from year to year are considerable. Once in two years out of 3-4 consecutive years, the rain is only 80% of the normal. Niphad has low rainfall. On an average there are 51 rainy days, at Peint they are 89, at Igatpuri 102, at Satana 32 and at Dindori 54.

Temperature.—Malegaon has the highest temperature in summer —40.6°C. Heat is intense particularly in plains. Humidity is high (80%) in monsoon, but only 20 to 25% in other seasons. The forest area belonging to Forest department is 3338.85 km² or 1289.13 sq. miles. All the regions in plains however are intensively cultivated. There are no forest based industries. The only industry is that of timber, firewood, charcoal and bamboos. On the north-west side the district opens into Dangs in Gujarat. Many plantations of teak and Eucalyptus are being raised by the Forest department in different areas for soil conservation and plant products.

Flora and Vegetation.—The flora of the district has not been fully described. Only stray observations have been made by workers on the flora of Tryambakeshwar, Vani (Saptashringi), Nasik, Surgana, Harsul and Igatpuri. The common cereal crops are Bajra in dry regions whereas tobacco, chillies, onion, and sugarcane are cultivated in regions abounding in water and having black cotton soils at Niphad, Yeola, Pimpalgaon Baswant, Malegaon and partly in Satana. There is shifting in the district, on account of which the Forest department is put to heavy loss.

Tryambakeshwar close to Nasik is a dry hill and supports sparse vegetation and dry scrub, despite the heavy rainfall 2456 mm compared to many other places. The list of plants there clearly shows dry deciduous nature of the vegetation. There is only dry scrub on top of Brahmagiri

plateau where surprisingly only a few stunted trees of *Ficus glomerata*, *Terminalia chebula*, *Semecarpus anacardium* and some bushes grow.

Average Annual Rainfall

	(in mm)
Nasik	696.0
Tryambakeshwar	2456.9
Igatpuri	3341.6
Sinnar	557.6
Yeola	555.3
Nandgaon	584.7
Malegaon	542.5
Satana	477.3
Dindori	753.1
Peint	2351.6
Total Nasik District ..	1034.5

The plants here suffer from extremes of rain, heavy winds, heat and soil erosion.

Bamboo brakes form good stands on the slopes and in plains below the foot of mountain ranges. The high plateau of Tryambakeshwar though receives heavy rains for three months, it becomes quite dry for want of rains and humidity for the rest of nine months of a year.

The vegetation, therefore, forms southern tropical deciduous forest of the poor type. Possibly the vegetation in earlier days was richer and better, but has now degraded into dry deciduous scrubby type. This is indicated by the list of plants at Tryambakeshwar also.

Another area from which the plants are known is Vani and Saptashringi in Dindori taluka. Plants of this place have been studied by Prof. P. B. Vaidya of H. P. T. College, Nasik and described by Cherian and Pataskar (1969) in *Bull. Bot. Surv. India*, Vol. **11** (102) : 22—34. The list of plants collected (given separately) clearly shows the vegetation of semi-arid type. The rainfall at Vani is medium, but the temperature is relatively high. The soil is poor, gravelly and not fertile.

The third area with good vegetation is Igatpuri having high rainfall. It has a ghat leading to Bombay. Here also the rains though heavy, water rushes down the hills and they have no vegetation. They look barren except for the ghat section where it is preserved in the valleys. It is of monsoon deciduous type with *Tectona grandis* as the major economic species. The trees however do not have very wide girth and yield mostly *bullis* or poles.

The fourth area of which flora is better known is Surgana-Harsul area bordering on the Dangs of Gujarat. It is close to Sahyadri ranges. It includes hill tops, valleys and slopes of Surgana range. Surgana once a small State is now a taluka in Nasik district. Harsul is close to Surgana. Both places are quite rich in plants. They have dry deciduous forests in which *Tectona grandis* predominates.

Cherian and Pataskar (1969) have had collected here 403 species belonging to 83 families of flowering plants and 5 pteridophytes. The first three families are Compositae (Asteraceae), Leguminosae (Fabaceae), and Gramineae (Poaceae).

Usually the hill tops of Sahyadris in this area are barren or have poor vegetation as in Igatpuri hills. Soil is lateritic, rainfall is 120—130" and maximum temperatures 30°—40° C. Soon after monsoons, rain water is drained off into valleys. The tops and slopes suffer from water scarcity for 8 months. Dew is formed in valleys in cold season and in low lying areas.

The important plant species are *Terminalia chebula*, *Terminalia crenulata T. bellerica*, *Tectona grandis*, *Adina cordifolia*, *Dalbergia lanceolaria* and shrubs like *Mallotus phillippinensis*, small trees of *Macaranga peltata*. Several herbs and grasses spring in monsoons. There is distinct ephemeral flora made up of Composites like *Senecio* and legumes like *Smithia*, Aroids like *Amorphophallus commutatus*, *Ariopsis peltata*, *Arisaema murrayi* etc. The vegetation here is obviously similar to that of valleys and hill tops of Sahyadris elsewhere e. g., Panchgani, Tryambak, but being close to Dangs in Gujarat, it contains also species common to that area. In spite of high rainfall, vegetation is sparse and hills barren. The vegetation in valleys is similar to that in Peint, Chikhaldara, and is composed of the similar species.

Only vegetation in plains is along the banks of large rivers like Godavari, Girna and smaller rivers like Darna and other streams. It is largely dominated by *Acacia arabica*, *Syzygium cumini*, *Morus alba* and *Bauhinia purpurea*. It does not represent climatic climax but post-climatic stage. In open or cleared areas species of bamboos and *Lantana camara* grow abundantly. On the whole the vegetation of Nasik district consists of mostly dry deciduous forest or scrub, with no rich dense forests except in Peint and Surgana talukas in valleys.

The plants of these four places are considered below.

5.2 : *Plants of Tryambakeshwar Hills* :

Tryambak or Tryambakeshwar lies at 73°.13—73°.30 E and 19°.54—19°.56 N. It is an important area from the view point of plants. It suffers from high rainfall, winds and erosion, notwithstanding its close proximity to Sahyadri ranges. The plateau on top of the range here is about 4.8 km from main range of Sahyadris. The place is very near to Nasik, 28.3 km distant. It is a very famous place of pilgrimage on account of the temple of Tryambakeshwar, which like Bhimashankar is one of the holy twelve *Jyotirlingas* of Lord Shiva. The temple and the town is 2448′ above MSL and was built by the third Peshwa Balaji Bajirav (1740—1761). The river Godavari is sacred to Maharashtra and Andhra people. It takes its origin here from a small cave on the top of the hill called Brahmagiri about 2808′ high, and 3.8 km distant from the main range of Sahyadri. Brahmagiri plateau is on the top of the hill. This hill like all hills around becomes dry after December due to rising temperature, high winds and low humidity. The vegetation consequently is of the dry deciduous type in spite of high rainfall.

The conspicuous important plant that forms sparse stands is *Tectona grandis*. On the top of the plateau occur *Terminalia bellerica*, *Capparis aphylla*, *Butea monosperma* bushes of *Pogostemon parviflorus*, *Adhatoda vasica*, *Woodfordia fruticosa*, *Barleria* sp. By the stream side *Polygo-*

num glabrum, Mentha viridis, Clematis gauriana, Vitis quadrangularis are seen. On the slopes of hills *Dalbergia sissoo, Daemia extensa, Rhus mysurensis* are seen. On the plateau and in shady places some ground orchids belonging to the genus *Habenaria*, and on trees *Dendrobium* plants grow. In the lower parts of valleys *Combretum ovalifolium* is frequently seen.

In the valleys the vegetation is better. It is however not so rich as that on Konkan side. In places there are moist deciduous forests. They contain *Anogeissus latifolia, Tectona grandis, Terminalia arjuna, Syzygium cumini, Semicarpus anacardium, Garuga pinnata, Boswellia serrata*. The small bushes of *Carissa congesta, Calycopteris floribunda* surround them in moist places, but in dry places *Acacia leucophloea* only grow.

Clumps of *Dendrocalamus strictus, Lantana camara* are there, but not frequent. Eight months being rainless humidity is low and only dried grass is seen. It does not make good pasture, but holds the soil surface well. Carpets of herbaceous plants and grass appear soon after the monsoons and form ephemeral flora. Hills of Tryambakeshwar, Saptashringi, Igatpuri, Kasara ghat have nearly the same sort of vegetation, representative of dry hills with heavy rainfall, poor soil and low humidity after the rains.

The list given here is compiled from the collection made by Prof. P. B. Vaidya (1969) and Dr. D. R. Mahajan (1978). On these hills *Sapindus laurifolius. Prosopis spicigera, Acacia catechu, Albizzia lebbeck, Dalbergia sissoo, Rhus mysurnsis, Barleria cristata, Woodfordia fruiticosa, Adhatoda vasica* are seen on the hill top, but disappear as we go higher. Creepers of *Combretum ovalifolium, Clematis gauriana, Hoya carnosa, Tinospora cordifolia* are seen on small trees, especially *Acacia arabica*. Orchids *Dendrobium* sp. and *Aerides crispum* grow epiphytically on trees on western side of the hill.

Mixture of dry xerophytic species such as *Prosopis spicigera* with ground orchids and tuberous plants on western side is noteworthy.

Plants at Tryambakeshwar and Hills Around

(after P. B. Vaidya and D. R. Mahajan)

Ranunculaceae :
Clematis gauriana

Menispermaceae :
Tinospora cordifolia

Anonaceae :
Anona squamosa

Capparidaceae :
Capparis aphylla
Cleome simphicifolia

Labiatae :
Pogostemon parviflorus
Ocimum sanctum

Portulaceaceae :
Portulaca oleracea

Cyperaceae :
Cyperus rotundus

Zygophyllaceae :
Tribulus terestris

Rutaceae :
Pervia elephantum

Amaranthaceae :
Amaranthus spinosus

Meliaceae :
Melia azadirach

Rhamnaceae :
Zizyphus jujuba

Vitaceae :
Evolvulus alsinoides

Sapindaceae :
Sapindus laurifolius

Anacardiaceae :
Rhus mysurensis
Mangifera indica

Moringaceae :
Moringa species

Papilionaceae :
Erythrina indica
Indigofera tinctorea
Pongamia glabra

Caesalipirnaceae :
Caesalpinia bonducella
Tamarindus indica
Albizzia lebebk

Mimosaceae :
Acacia arabica
Prosopis spicigera
Mimosa pudica

Combretaceae :
Terminalia arjuna
Combretum ovalifolium

Myrtaceae :
Syzygium cumini
Eucalyptus hybrida

Punicaceae :
Punica granatum

Lythraceae :
Woodfordia fruticosa
Lawsonia alba

Umbeliferae :
Centella asiatica

Compositae :
Lagasca mollis
Tagetes patula

Rubiaceae :
Ixora brachiata

Sapotaceae :
Mimusops elengi

Apocynaceae :
Plumeria acutifolia
Thevetia species
Rauwolfia serpentina

Oleceae :
Jasminum sp.

Asclepiadaceae :
Calotropis procera
Asclepias curasavica
Hoya carnosa

Boraginaceae :
Cordia mixa

Solanaceae :
Solanum indicum

Convolvulaceae :
Ipomoea palmata

Acanthaceae :
Adhatoda vasica
Barleria cristata
Justicia species

Verbenaceae :
Duranta plumeriana
Tectona grandis
Vitex negundo

Amaranthaceae :
Celsia argenteana

Chenopodiaceae :
Chenopodium alba

Polygonaceae :
Polygonum species

Euphorbiceae :
Euphorbia hirta
Euphorbia geniculata
Euphorbia antiquorum
Euphorbia tirucalli
Pedilathus tithymeloides
Phyllanthus emblica
Jatropha gossypifolia

Orchidaceae :
Dendrobium species (Ground orchid)
Aerides crispum (Epiphytic)

Commelinaceae :
Commelina begalensis

Gramineae :
Setaria glauca
Eleusine indica
Dendrocalamus strictus

5·3. Plants of Igatpuri (Kasara) Ghat :

Igatpuri, lies at the entrance of a pass, 607 m above the M. S. L. or 1992', on the main line of Central Railway. It is a hill station. The climate is cool and equable. The average mean annual temperature is 25° C. The rainfall is high 3341.6 mm. Rainy days in the year are 101. The rainfall varies from 2032 mm. to 2667 mm. or 80-105". Naturally one expects much more cool weather, but it is not so, as after the rainy season heat emanates from the surrounding denuded hills during day time. However it cools down in the evening, and nights are quite cool. Tnere is not much humidity in air after monsoons, and the place becomes very dry. Kasara ghat leading to Bombay and Harishchandra ranges are more like ghats on west side of Sahyadris.

Dominant tree species are *Tectona grandis* and *Adina cordifolia* mostly in the valleys. Many trees of *Eucalyptus* have been planted by the Forest Department, but in the hard denuded areas devoid of soil, they do not seem to prosper well. In the midst of Kasara ghat and in ghat leading to Kalasubai *via* Ghoti, one sees bushes of *Lasiosiphon erіociphalus, Elaegnus conferta, Barleria involucrata, Allophyllus cobbe, Carissa congesta, Euphoriba neridifolia, Lobelia nicotianaefolia* etc. Many herbaceous species such as *Heracleum concanense, Pusedinum grande, Senecio dalzelli,* grasses like *Heteropogon, Apluda* grow abundantly. On the escarpments at high level *Terminalia crenulata, Lagerstroemia lanceolata, Dalbergia lanceolaria, Bridelia retusa, Ixora brachiata, Glochidion hohenackeri, Schleichera trijuga* are common. In places in the lower reaches of ghats, one sees *Ceiba malabarica*. On the outskirts of ghat forest *Calicopteris floribunda, Combretum ovalifolium Diospyros montana* and *Holarrhena antidysenterica* are noticed. *Tectaria maerodenta* is a common fern on forest floor. The open spaces have monsoon ephemerals, but with some temperate species.

The flora and vegetation here are essentially of the same type as in other ghats, but rather dry and poor. The vegetation except in the valleys is mixed dry deciduous. The trees of *Tectona grandis* are tall. They mostly make poles. They do not form good timber as those in Thane district forests. The poor soil, lack of humidity and water, emanation of heat and quick loss of water from mountain slopes are responsible for it.

5·4. Flora of Saptashringi Hills :

The flora of this famous place has been studied by Prof. P. B. Vaidya of H. P. T. College, Nasik and by Dr. P. J. Cherian and R. D. Pataskar (1969). The latter's observations have been published in *Bull. Bot. Surv. India*, **11** (1 and 2) : 23—34, 1969. The hill is seven-horned or seven crested. The species of angiosperms here were collected by Prof. P. B. Vaidya in rainy season and in late winter and therefore, his list is given separately. He collected 160 species belonging to 53 families, while climbing the nill from Dindori side. It contains many herbaceous species that were not collected by Cherian and Pataskar (1969). Their collection was made in rainy season.

Saptashringi lies between 73°51′-73°58′ E and 20°20′-20°27′ N. It is about 64 km from Nasik. It is the seat of Saptashring Nivasini Devi, sacred to all Hindus, particularly from Nasik, Jalgaon, Dhule and Ahmednagar Districts.

The altitude of the place is 1420.06 metres. It is surrounded by other peaks, the prominent among which is Markunda 1461 m high. There is a broad plateau at the top, the topmost part being a sharp scarp. The Dattatreya temple is a little below the Devi temple on the topmost point. The middle part of the hill is a barren rock formed by the Deccan trap. It forms coarse gravelly soil. The hill lies a little in the interior, off the main Sahyadri range on a lateral spur extending from Chandwad eastwards. The vegetation is mostly on the lower part of the hill and in the valleys where soil is better. On the upper part of the hill the soil is brown, but in the valleys it is black. The hill tops have scarcely any soil as they are eroded due to high winds and rains. Only a few trees and shrubs occur on the high slopes and in valleys. The climate like that of many parts of Nasik district is dry for 8 months of a year. Rainfall is very high, mostly from June to September. Daily mean temperature maximum 31°.1 C and minimum 16°.9. Relative humidity is 69.07%.

Vegetation.—The vegetation is of dry deciduous type, largely governed by the topographic, edaphic and human factors. They have greatly affected the vegetation here. On the eastern side near Daregaon there is Daityacha Dongar. There is some forest, but not dense as the edaphic factors seem to operate severely on the area. The vegetation on the slopes on eastern and western sides of Saptashringi hill, Markunda hill, is covered by *Tectona grandis, Anogeissus latifolia, Terminalia crenulata* plant communtiy, mostly at the foot of these hills. Above 600 m the vegetation changes. On the west side it becomes xerophytic. Here and there, there are trees of *Terminalia crenulata, Boswellia serrata, Garunga pinnata, Dalbergia lanceolaria, Lannea coromandelina, Anogeissus latifolia, Lagerstroemia parviflora, Bridelia squamosa, Bombax ceiba, Butea monosperma* etc. Their growth however is neither profuse nor poor. It is medium.

On open exposed slopes *Lantana camara* var. *aculeata, Acacia nilotica Zizyphus mauritiana* are formed side by side with *Bidens pilosa* and *Cassia absus.* Bushes of *Diospyros melanoxylon, Ougenia ougenioides* and some grasses grow simultaneously. A few plants of *Glochidion hohenackeri, Xeromphis spionsa, Holarrhena antidysenterica, Syzygium cumini* occur in moist protected places. Several grasses like *Themeda quadrangulaire, Apluda mutica, Arundinella pumila, Cymbopogon martini, Heteropogon contortus, Eragrostis pilosa* grow abundantly. On the forest floor in shade grows a fern *Tectaria* species as a common undergrowth. Many woody creepers *Aspidopteris cordata, Dioscorea pentaphylla, D. bulbifera, Dragea volubilis, Rivea hypercrateriformis* are found growing on trees and bushes in the forest. A few herbaceous climbers such as *Coceullus hirsutus, Mukia maderaspatana* are also found.

After the middle part of the hill, vegetation becomes thorny, dry and sparse. *Euphorbia neriifolia, Aerua leucacephala, Carisse congesta* become dense with bushes of *Neuracanthus* and *Bidens pilosa.* This is a transitional zone and bushes of *Glochidion hohenackeri* and *Trema orientalis* get mixed with xerophytic species of scrub.

During monsoons ephemeral flora appears on flat plains and plateaus on the small and large hill flats. It consists of *Biophytum sensitivum*, *Heylandia latebrosa*, *Crotalaria mysureneis*, *Alycicarpus vaginalis*, *Smithia purpurea*, *Commelina* and *Justicia* species.

High peaks of Saptashringi and Markunda do not have any trees or even shrubs. They support only grasses such as *Setaria glauca* and a few others. In the ledges of rocks and on moist vertical cracks and crevices some soil accumulates and *Senecio grahami*, *Anotis latifolia*, *Evolvulus alsinoides*, *Justicia simplex*, *Cassia pumila* and grasses grow in rainy season. Even on very small platforms *Senicio grahami*, *Crotalaria prostrata*, *Dysophylla stellata*, *Exacum bicolor*, *Exacum pedunculata*, *Linderina sessilis*, *Impatiens dalzellii*, *Impetiens cleinei*, *Striga densiflora*, *Utricularia uliginoides*, *Eriocaulon* species grow. Ground orchids like *Habeinaria rariflora* grow in the midst of dense small grass. With the onset of monsoons many tuberous plants like *Iphigenia indica*, *Chlorophytum glaucum*, *Hypoxis orea*, *Curculigo orchioides*, *Cynotis fasciculatus*, *Impatiens balsamina* begin to grow and come in full bloom by about August forming showy carpets.

Cherian and Pataskar (1969) visited the hill after monsoons, and were able to collect 245 species belonging to 68 families of angiosperms. Important among them are given separately.

Flora of Saptashringi (Vani) :

Plants enumerated by Prof. P. B. Vaidya.

Ranunculaceae :
Clematis gouriana Roxb.
Clematis triloba Heyne ex Roth

Magnoliaceae :
Michelia champaca Linn.

Anonaceae :
Anona squamosa Linn.

Menispermaceae :
Cyclea burmanni (DC) Hook F. and Roth
Cissampelos pereira Linn.
Cocculus hirsutlus (Linn.) Diels

Papaveraceae :
Argemone mexicana Linn.

Cruciferae :
Cardamine trichocarpa Hoehst

Polygalaceae :
Polygala persicarifolia DC

Portulacaceae :
Portulaca oleracea Linn.

Malvaceae :
Sida acuta Burm. f.
Sida acuta var. *retusa*
Urena lobata Linn.
Hibiscus rosa-sinensis Linn.
Thespesia populnea (Linn.) Sol. ex Cerr.

Bombacaceae :
Salmalia malabarica (DC) Sch.

Tiliaceae :
Triumfetta rhomboides Jacq.

Linaceae :
Linum mysurense Heyne ex Benth

Oxalidaceae :
Oxalis corniculata Linn.

Balsaminaceae :
Impatiens balsamina Linn.
I. balsamina Linn. var. *corymbosa* sant.
I. oppositifolia Linn.
I. acaulis Arn.

Meliaceae :
Melia dubia Hiern
Azadirachta indica A. Juss.

Celastraceae :
Gymnosporia rothiana Laws

Rhamnaceae :
Zizyphus rugosa Lamk.

Anacardiaceae :
Mangifera indica Linn.

Fabaceae-Papilionaceae :
Heylandia latebrosa DC.
Crotalaria nana Burm. f.
Indigofera enneaphylla Linn.
I. glandulosa Roxb.
I. cordifolia Heyn ex Roth
I. lineafolia (Linn. f.) Retz.
Smithia conferta Sm.
S. purpurea Hook.
S. setulosa Dalz.
Alysicarpus tetragonolobus Edgew.
A. rugosus (Willd.) DC.
A. vaginalis (Linn.) DC.
Ternamnus ladiaris (Linn. f.) Spreng.
Zornia diphylla (Linn.) Pers.
Erythrina stricta Roxb.
Butea monosperma (Lamk) Tall.
Vigna radiata (Linn.) Wikz.
Vigna vexillata (Linn.) A. Rich.
Vigna capansis Walp.
Phaseolus radiatus (Linn.)
P. aconitifolius Jacq.
Dolichos biflorus Linn.
Atylosia scabraecides (Linn.) Benth.
Cylista scariosa Roxb.

Caesalpineaceae :
Cassia pumilla Lamk.
Bauhinia racemosa Lamk.

Mimosaceae :
Albizzia amara (Roxb.) Beivin
Acacia intsia Willd.

Combretaceae :
Terminalia crenulata Roth
Anogeissus latifolia Bedd

Myrtaceae :
Syzygium cumini (Linn.) Skeels

Lythraceae :
Ammannia multiflora Roxb.
Woodfordia fruticosa (Linn.) Kurz

Begoniaceae :
Begonia cencanensis DC.

Umbelliferae :
Pimpinella tomentosa Dalz.
Heracleum conkanense Dalz.

Rubiaceae :
Oldenlania herbacea Roxb.
Anotis lancifolia Hook. f.
Anotis foetida (Dalz.) Lewis
Borreria stricta K. Sch.

Compositae :
Pavetta indica Linn.
Centratherum phyllolaenum (Bth.) ex Hook. f. Benth.
Ageratum conyzoides Linn.
Cyathocline purpurea (D. Don) Kuntze
Eclipta prostrata (Linn.) Linn
Eclipta alba (Linn.) Hassk.
Bidens biternata (Lour.) Merr. and Sherrif
Vicoa indica DC.
Tridax procumbens Linn.
Xanthium strumarium Linn.
Artemesia nilagirica (C. B. Cl.) Pamp.
Gynura angulosa DC.
Emilia sonchifolia DC.
Senecio grahami Hook. f.
Guizotia abyssinica Cass
Acanthospermum hispidum DC.

Plumbaginaceae :
Plumbago zeylanica Linn.

Oleaceae :
Olea dioica Roxb.

Apocynaceae :
Wrightia tinctoria R. Br.
Carissa congesta W. f.
Nerium indicum Mill

Genteniaceae :
Swertia minor (Griseb) Knobl.

Boraginaceae :
Trichodesma amplexicaule Roth.
Cynoglossum wallichii D. Don
Cynoglossum glochidiatum Wall.
Adelocaryum coelestinum (Linn.) Branch.

Convolvulaceae :
Ipomoea nil (Linn.) Roth.
Argyreia sericea Dalz.
Cuscuta reflexa Roxb.

Solanaceae :
Solanum indicum Linn.
Nicandra physaloides (Linn.) Gaertn.

Scrophulariaceae :
Bacopa monieri (L.) Pennell.
Kickxia ramosissima (Wall.) Junchen .
Linaria remosissima Wall.
Lindernia ciliata (Colsm) Pennell
Rhamphicarpa longiflora (Arn.) Benth.
Sopubia delphinifolia D. Don.

Lentibulariaceae :
Utricularia striatula Sm.
U. uliginosa Vah.

Acanthaceae :
Asteracantha longifolia Nees.
Asystasia dalzelliana Santapau.
Justicea simplex Don.
Rungia repens (L.) Nees.
Lepidagathis cristata Willd.

Verbenaceae :
Lantana camara Linn.
Tectona grandis Linn. f.
Vitex neguno Linn.
Clerodendren serratum Linn.

Labiatae :
Plectranthes mollis (Ait.) Sprang.
Pogostemon benghalense (Burm.) Kunge.
Pogostemon plectranthoides Des.
Colebrookea oppositifolia Sm.

Nyctaginaceae :
Boerhaavia diffusa Linn.

Amaranthaceae :
Celosia argentea Linn.
Achyranthes aspera Linn.
Alternanthera sessilis (L.) DC.

Polygonaceae :
Polygonum plebejum R. Br.
P. glabrum Willd.
Euphorbia antiquorum Linn.
E. hirta Linn.
E. elegans Spreng.
Bridelia squamosa Gehrm.

Mallotus philippinensis (Lamk) Muell. Arg.
Fleurya interrupta Gaud
Boehmeria scabrella (Roxb.) Gaud.

Moraceae :
Ficus religiosa Linn.

Orchidaceae :
Habenaria rariflora A. Rich.
Dendrobium microbulbum Rich.
Eria dalzellii Lindl.
Aerides crispum Lindl.

Hypoxydaceae :
Hypoxis aurea Lour

Dioscoreaceae :
Dioscorea pentaphylla Linn.

Commelinaceae :
Commelina bengalensis Linn.
C. obliqua Buch. Ham.
Murdannia spiratum (L.) Bruckn.
Cyanotis tuberosa (Roxb.) Schult. f.

Eriocaulaceae :
Eriocaulon sp.

Cyperaceae :
Cyperus brevifolius (Rottb.) Hassk.
C. triceps (Rottb.) Endl.
C. corymbosus Rottb.
C. flavesvcens Linn.
C. iria Linn.
C. metzii (Hochst.) Mattf. and Kuck
Fimbristylis tera R. and S.

Gramineae :
Cynodon dactylon (Linn.) Pers.
Echnochlea colenum (Linn.) Limk.
Garnotia stricta Brongn.
Paspalum compactum Roth.
Setaria glauca (Linn.) Beauv.
Bothriocloa pertusa (Linn.) A. Camus.
Digitaria stricta Roth ex R. and S.
Eleusine coracana (Linn.) Gaertn.
Sehima nervosum (Roth.) Stapf.

Ferns or Filicales :
Adiantum lunulathum
Cheilanthes sp.
Athyrium Sp.
Asplenium Sp.

Bryophyta :
Riccia sp.
Fimbriaria Sp.
Targionia sp.
Cythodium sp.
Mosses about 10. species.

List of Important Plants Collected at Saptashringi Hills by Cherian and Pataskar, 1969

Menispermaceae :
Cocculus hirsutus (Linn.) Diels.
Tinospora cordifoliaa (Willd.) Miers.

Cruciferae :
Cardamine trichocarpa Hochst. Ex Rich.

Capparidaceae :
Capparis sepiaria Linn.

Cleomaceae :
Cleome viscosa Linn.
C. simplicifolia Hook. f. and Thoms.

Flacourtiaceae :
Flacourtia indica (Burn. f.) Merr.

Polygalaceae :
Polygala chinensis Linn.

Malvaceae :
Azanza lampas (Cav.) Alef.
Hibiscus lobatus (Murr.) Ktze.
Sida rhombifolia Linn.

Sterculiaceae :
Helicteris isora Linn.

Tiliaceae :
Corchorus trilocularis Linn.
Grewia abutilifolia Linn.
Triumfeta rhomboidea Jacq.
T. rotundifolia Lam.

Linaceae :
Linum mysurense Heyne ex Benth.

Malphigiaceae :
Aspidopterys cordata (Hayne) A. Juss.

Balsaminaceae :
Impatiens balsamina Linn.
I. kleinii wt. and Arn.

Burseraceae :
Boswella serrata Roxb. ex Coleber.
Garuga pinnata Roxb.

Celastraceae :
Elaeodendron roxburghii Wt. and Ar.

Rhamnageae :
Zizyphus mauritiana Lamk.
Z. nummularia (Burm. f.) Wt. and Arn.
Z. rugosa Lamk.

Vitaceae :
Havratia carnosa (Lamk.) Gagnep.

Sapindaceae :
Cardiospermum halicacabum Linn.

Anacardiaceae :
Lannea corodmandelica (Houtt.) Morr.

Fabaceae :
Aeschynomene aspera Linn.
A. tetragonolobus Edgw.
Alysicarpus procumbens (Roxb.) Sc.
A. vaginalis (Linn.)
Butea monosperma (Lamk.) Taub.
Crotalaria mysorensis Roxb.
C. orixonsis Willd.
Dalbergia lancelaria Linn. f.
D. laxiflorum DC.
D. glandulosa Roxb. ex. Willd.
Rhynchosia minima DC.
R. rothii Benth. ex Ait.
Smithia bigemina Dalz.

Caesalpiniaceae :
Cassia absus Linn.
C. fistula Linn.

Mimosaceae :
Acacia intsia Willd.

Combretaceae :
Anogeissus latifolia Wall. ex. Bedd.
Terminalia crenulata Roth.

Lythraceae :
Rotala densiflora (Roth) Koenhne.

Cucurbitaceae :
Diplocyclos palmatus (L.) Jeff.
Dicoglospermum ritchiei Clarke.

Begoniaceae :
Begonia crenata Dryand.

Aplaceae :
Pimpinella heyneana Wall.
P. tomontosa Dalz. ex C. B. Clarke

Rubiaceae :
Borreria articularis (Linn. f.) F. N. Will.
Mitragyna parvifolia (Roxb.) Korth.
M. maheshwarii Sant. and Mahesh.
Xeromorphis spinosa (Thumb.) Keay.

Asteraceae :
Acanthospermum hispidum DC.
Sclerocarnus africanus Jacq.
Senecio grahami Hook. f.
S. hewrensis Hook. f.

Campanulaceae :
Cephalostigma schimperi Hocht ex A. Rich.

Myrsinaceae :
Embelia tsjeriam cottam A. DC.

Sapotaceae :
Madhuca indica Gmel.
Xantolis tomentosa (Roxb.) Raf.

Ebenaceae :
Diospyros melanoxylon Roxb.

Oleaceae :
Nyctanthes arbor-tristis Linn.

Apocynaceae :
Holarrhena antidysenterica (Linn.) Wall.
Wrightia tinctoria R. Br.

Periplacaceae :
Cryptolepis buchnani Roem. and Sch.
Pergularia daemia (Forsk.) Chiev.
Tylophora dalzelli Hook. f.

Gentianaceae :
Enicostema verticillatum (Linn.) Engler.
Exacum lawii C. B. Clarker.

Boraginaceae :
Cynoglossum meeboldii Brand.

Lentibulariaceae :
Utricularia lignosa Vahl.

Bignoniaceae :
Heterophragma quadriloculare (Roxb.) K. Sch.

Acanthaceae :
Nilgirianthus heyneanus Bremek. var. *neesii* Bremek.

Thunbergiaceae :
Thunbergia laevis Ness.

Verbenaceae :
Clerodendrum serratum (Linn.) Monn.
Tectona grandis Linn. f.

Lamiaceae :
Dysophylla stellata Benth.
Lavendula bipinnata (Roxb.) O. Ktze.

Euphorbiaceae :
Acalypha malabarica Muell. Arg.
Bridelia squamosa Garhm.
Glochidion hoheneckeri Bedd.
Mallotus philippinensis (Lamk.) Muell. Afg.
Securinega virosa (Roxb.) ex willd. Pax and Hoffm.

Moraceae :
Ficus microcarpa Linn. F.

Urticaceae :
Fleurya interrupta (Linn.) Gaud.
Lecanthus peduncularis (Wall.) Wedd.
Pouzolzia zeylanica

Orchidaceae :
Aerides crispum Lindl.
Habenaria digitata Lind.
H. rariflora A. Rich.

Hypoxidaceae :
Curculigo orchioides Gaertn.
Hypoxis aurea Lour

Zingiberaceae :
Curcuma pseudomontana Grah.

Dioscoreaceae :
Dioscorea bulbifera Linn.

Liliaceae :
Asparagus racemosus Willd. var *javanicus* Baker

5·5: Flora of Surgana—Harsul Ranges :

Surgana formerly a small State, is now a taluka in Nasik district. It lies close to Dangs in South Gujarat and to the north-west of Dindori. It lies at 20°.0′—20°.40′ N and 73° 15-73° 45′ East. The region is highly rugged. It has many deep ravines and narrow ridges and cross spurs, drained by several streams and rivers such as Par, Nar and Dawan. Soils are derived from the Deccan trap and are basaltic. The average altitude of the track is 600 m. The highest peak in Surgana is 884 m. The soils are (1) rich dark or black in valleys and ravines, (2) dark greyish green on slopes full of murum, and (3) reddish lateritic on hill tops and at higher elevations. They have matured under different conditions at different periods.

The average annual rainfall is 1900 mm between June and October. The maximum temperature in summer is 30-40°C and the minimum in winter is 10°C. The average mean temperature is not known. The flora of this place has been studied by Dr. P. J. Cherian and R. D. Pataskar (1969) who have published a paper on it in *Bull. Bot. Surv. India* **11** (2 and 3) : 381—397. They collected 430 species of angiosperms belonging to 83 families, besides 5 species of pteridophytes—all ferns; and a few liverworts.

Vegetation.—The vegetation is mostly of dry deciduous type with some small grassy patches. In the ravines and valleys moist deciduous or semi-evergreen species are found e.g. *Madhuca longifolia* var *latifolia, Mitragynas parviflora, Ficus arnottiana, Ficus nucricaroa, Schleichera trijuga* (=*S. oleosa*), *Terminalia bellerica*. Due to high humidity there are many epiphytic orchids like *Rhycostyliis retusa, Dendrobium* species. Mosses occur on all trees. In small ponds *Ceratopteris thallictorides, Limnophyton indicum, Ceratophyllum demersum* occur in masses.

In some valleys really good semi-evergreen species are seen. They are *Erinocarpus nimmonii, Cassia glauca, Schleichera oleosa, Dalbergia lanceolaria, Bauhinia malabarica, Terminalia chebula, Syzygium cumini, Stereospermum chelonoides*, Tremma *orientalis* etc. Some valleys also contain some dry elements like *Adina cordifolia, Tectona grandis, Terminalia crenulata, Terminalia chebula, Dalbergia latifolia, Lagerstroemia parviflora, Gmelina arborea* etc.

Lagerstroemia lanceolata, Macuranga peltata, Ficus virens Diospyros melanoxylon occur deep down in valleys as moist deciduous species.

The dry deciduous forests grown in several open valleys and slopes are dominated by *Tectona grandis*, *Dalbergia latilolia*, *T. chebula* and *T. crenulata* plant community, but can also grow in moist places.

A special noteworthy feature of the vegetation here is the mixture of dry and moist deciduous species both encircled by shrubs of *Carissa congesta*, *Helicteris isora*, *Flacourtia indica*, *Clerodendron serratum*, *Vitex negundo*, *Acacia torta*, *Meyna taxifolia*, *Pavetta indica*, *Grewia abutilifolia* at the edge of forests. The proportion of semi-evergreen species increases as we advance towards Dangs but it becomes less as we approach the plains. Finally they all merge into one another, *Tectona grandis* becoming conspicuous in Dangs and bamboos in Bansada in South Gujarat.

To get further picture of vegetation here, a list of selected plants noted by Cherian and Pataskar (1969) is given below.

On the top of mountain monsoon ephemeral flora occurs full of herbs like *Cleome simplicifoliia C. chelidoni*, *Biophytum sensitivum*, several legumes and small grassess *Senecio grahami*, *Smithia setulosa*, *Smithia conferta*, *Impatiens balsamina*, *Cardamine trichopus*, *Habenaria digitata*, *Iphegenia indica* occur in plenty.

On the slopes and shady mountain sides several important species of grass grow such as *Sporobolus albidus*, *Panicum montanum*, *Themeda quadrivalvis*, *Trilobachnae species*, *Manisurus clarkei*. They are especially noticeable near the villages Sawarna, Zhari, Boripada, etc.

ENUMERATION OF IMPORTANT SPECIES IN SURGANA—HARSUL RANGE

Ranunculaceae :	Flowering Season
Clematis hedysarifolia DC	N. A.
Dilleniaceae :	
Dillenia pentagyna Roxb.	July
Menispermaceae :	
Cissampelos pareira Linn	September
Cyclea burmanni DC H. K. and Th ..	..
Tinospora cordifolia (Willd.) Mierar ..	..
Papaveraceae :	
Argemone mexicana Linn.	July
Brassicaceae :	
Cardamine trichocarpa Hocch st es Rich ..	July
Flacourtiaceae :	
Flacourtia indica (Burm f.) Merr.	July
Caryophyllaceae :	
Polycarpon prostratum (Forsk.) Aach. and Schwr.	July
Malvaceae :	
Azanza lampas (Cev.) Alef.	July—September
Hibiscus furcatus Roxb.	September
H. vitifolius Linn.	September
Sida alba Linn.	September
Thespesia populnea (L.) Soland ex. Corr.	September

Tiliaceae :	
Eriocarpus nimmonii Grah.	September
Grewia glabra Bl.	September
Triumfetta pillosa Roth	September
Linaceae :	
Linum mysorense Heyne ex Bentn.	September
Malpighiaceae :	
Aspidopterys cordata A. Juss.	September
Balsaminaceae :	
Impatiens balsamina Linn	September
I. kleinii Wt and Arn.	September
Rutaceae :	
Aegle marmelos Corr.	September
Vitaceae :	
Ampelocissus latifolia (Roxb.) Planch	September
Cissus pallida (Wall. ex. W. and A.) Planch	September
Leeaceae :	
Leea edgeworthii Sant.	July—September
L. macrophylla Roxb.	July—September
Sapindaceae :	
Schleichera oleosa (Lour) Oken	
Fabaceae :	
Aeschynomene indica L.	September
Alysicarpus bupleurifolius (L.) DC	September
A. vaginalis DC	September
Atylosia platycarpa Benth	September
Butea monosperma (Lamk.) Ktze	
B. superba Roxb.	
Crotalaria juncea Linn. f.	September
C. mysorensis Roth	September
C. nana Burm.	September
C. triquetra Datz.	
Dalbergia lanceolaria Linn	July
D. latifolia Roxb.	
Desmodium diffusum DC.	September
D. gangeticum DC	
D. heterocarpon (L.) DC	September
Dolichos falcatus Klein ex Willd.	September
Indigofera astragalina DC.	September
Phaseolus dalzelliana (O. K.) Verde	September
=*Phaseolus khandalensi* Sant.	September
Phaseolus radiatusc L.	September
Pongamia pinnata (L.) Pierre	July—September
Rhynchosia rothii Benth ex Altch.	September
Sesbania bispinosa (Tacq.) Wt.	September
S. sesban (Linn.) Merr	September
Teramnus labialis (Linn. f.) Spr.	September
Vigna vexillata (L.) Rich.	September
Caesalpiniaceae :	
Bauhinia lawii Benth	
B. malabarica Roxb.	
B. racemosa Lamk.	July

Cassia absus L.	September
C. fistula L.	September
C. obtusifolia L.	September
Mimosaceae :	
Acacia pinnata Willd.	September
A. polyantha Willd.	July
A. sinuata (Leur.) Merr.	September
A. torta (Roxb.) Craig	July—September
Combretaceae :	
Anogeissus latifolia Beod.	
Calycopteris floribunda Lamk.	
Combretum ovalifolium Roxb.	July—September
Terminalia bellerica Roxb.	July
Terminalia chebula Retz.	July—September
T. crenulata Roth	July
Myrtaceae :	
Syzygium cumini (L.) Skeels	September
Lecythidaceae :	
Careya arborea Roxb.	July
Lythraceae :	
Ammannia multiflora Roxb.	September
Lagerstroemia parviflora Roxb.	July—September
Rotala aqualica Rour	September
Woodfordia fruticosa (L.) Kurz	July
Cucurbitaceae :	
Bryonopsis laciniosa (L.) Naud.	September
Dicoelospermum ritohiei Clarke	September
Apiaceae :	
Peucedanum grande Cl.	September
Pimpinella heyneana Wall.	September
Rubiaceae :	
Adina cordifolia (Roxb.) Hook. f.	September
Borreria articularis (L.) F. N. Wall.	September
Gardenia latifolia Ait.	July
Hymenodictyon obovatum Wall.	July
Meyna laxiflora Robyns	July
Mitragyna parvifolia (Roxb.) Korth.	July
Pavetta crassicaulis Berm.	
Spermadictyon suaveolens Roxb.	September
Xeromphis spinosa (Thunb) Kedy	July
Asteraceae :	
Blumea mollis (Don) Merr.	
Caesulia axillaris Roxb.	September
Eclipta prostrata (Limm. F.) L.	July—September
Emilia sonchifolia DC.	September
Sclerocarpus africanus Jacq.	September
Senecio grahami Hook. f.	September
Tricholepis glaberrima DC.	September
Lobeliaceae :	
Lobelia aslinoides Lamk.	September
Plumbaginaceae :	
Plumbago zeylanica L.	September

Primulaceae :	
Anagallis purmila SW.	September
Myrsinaceae :	
Embelia tojerium cottam DC.	July—September
Ebenaceae :	
Madhuca longifolia Mac	
var. *latifolia* (Roxb.) Chev.	July
Sapotaceae :	
Diospyros melanoxylon Roxb.	July
Oleaceae :	
Jasminum malabaricum Wt.	July
Apocynaceae :	
Carissa congesta Wt. ..	September
Holarrhiena antidysenterica A. DC. ..	July—September
Wrightia tinctoria R. Br.	July—September
Asclepiadaceae :	
Glianthus deccanensis Talb.	September—October
Tylophora dalzelli Hook. f.	September
Gentianaceae :	
Canscora concanensi C. B. Cl.	September
Swertia minor Knobl.	September
Boraginaceae :	
Adelocaryum caelestinum (Lindl) Brand.	September
Cordia dichotoma Forst. f.	
Heliotropium Indicum L.	September
Convolvulaceae :	
Argyreia sericea Dalz.	September
Ipomoea clarkei Hook. f.	September
I. digitata L.	September
I. eriocarpa R. Br.	September
I. muricata (L.) Jacq.	September
Solanaceae :	
Nicandra physaloides (L.) Gaeth. ..	September
Solanum indicum L.	July—September
Scrophulariaceae :	
Buchnera hispida Buch. Ham.	September
Limnophila indica (L.) Druce.	September
Kubderbua cukuata (Colsm.) Penn. ..	September
Lindernia nummularifolia (Don) Wettst. ..	September
Torenia cordifolia Roxb.	September
Bignoniaceae :	
Dolichandrone falcata Seen.	July
Oroxylum indicum (L.) Vent	
Stereospermum chelonoides DC.	
Pedaliaceae :	
Sesamum mulayanum Nair	September
Thunbergiaceae :	
Thunbergia laevis Nees	September

Acanthaceae :	
Barleria cristata L.	September
B. prattensis Sant.	September
Carvia callosa (Wall.) Brem.	July—September
Hemigraphis laterbrosa Nees	September
Justicia betonica L.	September
Lepidagathis cuspidata Nees	September
Neuracanthus sphaerostachyus Dalz. ..	September
Rungia elegans Dalz. and Gibbs.	September—October
Verbenaceae	
Clerodendrum serrutum (L.) Moon. ..	July—September
Gmelina arberea Roxb.	July
Tectona grandis L. f.	July
Vitex negunda L.	July
Lamiaceae :	
Acrocephallus indicus (Burm.) Ktze ..	September
Anisochilus carnosus Wall.	September
Leucas aspera Spreng	September
L. lavandulaefolia Nees	July—September
L. zeylanica R. Br.	September
Ocinum americanum L.	September
Plectranthus mollis (Airt) Spr.	September
Amaranthaceae :	
Alternanthera sessilis (L.) R. Br.	July—September
Amaranthus spinosus L.	September
Celosia argentea L.	September
Polygonaceae :	
Polygonum glabrum Willd.	September
P. plebejum R. Br.	September—October
Loranthaceae :	
Dendrophthoe falcata (L. f.) Ctt. ..	September
Viscum articulatum Burm.	July—September
Emphorbiaceae :	
Bridelia retusa Spr.	July
B. squamosa Graham	July
Macaranga peltata Muell. Arg.	
Mallotuus philippinsis Muell. Arg. ..	July—September
Manihot glaziovii Muell. Arg.	July
Phyllanthus asperulatus Hutch.	July
P. emblica L.	September
Securinega virosa Roxb. ex. Willd. pax & Hffm.	July—September
Ulmaceae :	
Trema orientalis L. Bl.	July—September
Boehmeria scabrella (Roxb.) Gaud. ..	
Fleurya interrupta (L.) Gaud.	September
Pouzolzia zeylanica (L.) Benn.	July—September
Moraceae :	
Artocarpus heterophyllus Lamk.	
Ficus arnottiana Mig.	July
Ficus asperrima Roxb.	September

F. bengalensis L.	July
F. racemosa L.	July
F. microcarpa Lim. f.	July
F. virens Aitvar *virens*	July
F. tsiela Roxb.	July
Orchidaceae :	
Aerides crispum Lindl.	July
Eria dalzellii Lindl	September
Habenaria commelinifolia Wall. ex Lindl.	July
H. digitata Lindl.	July
H. grandifloriformis Blatts and McC.	July
H. plantaginea Lindl.	September
Plantanthera susanae (L) Lindl.	September
Rhynchostylis retusa Bl.	July
Zingiberaceae :	
Costus speciosus (Koenb) Sm.	September
Curcuma pseudomontana Greham	July
Hypoxidaceae :	
Curculigo orchioides Gaertn	July
Hypoxis aura Lour.	July
Taccaceae :	
Tacca leontopetaloides	July—September
T. pinnatifida Porst.	
Dioscoreaceae :	
Dioscorea bulbifera L.	July—September
D. oppositifolia L.	July—September
D. pentaphylla L.	September
D. wallichii Hook f.	
Liliaceae :	
Asparagus racemosus Willd.	September
Chlorophytum tuberosum Baker	July
Gloriosa superba L.	September
Iphigenia indica A. Gray	July
Scilla indica Baker	July
Urginea indica Baker	July
Commelinaceae :	
Commelina diffusa Burm. f.	September
C. hasskarii C. B. Cl.	September
C. kurzii C. B. Cl.	September
C. peteata Hassk.	September
C. suffruticosa B.l.	September
C. notis cristata (L.) Don.	September
C. fasciculata (Heyne ex Roth) Sch. f.	September
Murdamnia nudiflora (L.) Brenan.	September
M. semiteres (Dalz.) Sint.	September
M. spirata (L.) Brueckn.	September
Araceae :	
Amorphophallus commutatus (Schott.) Engler	October
Ariopsis pettala Nimmo	July
Arissaema murrayi Hook.	July
Remusatla vivipara (Roxb.) Schott.	September

Eriocaulaceae :

Eriocaulon dianae Fyson	September—October
E. margaretae Fyson	September

Cyperaceae :

Cyperus flavidus Retz	September
C. globosus All.	September
C. iria L.	September
Courtoisia cyperoides Nees	October
Eleocharis capitata R. Br.	September
Fimbristylis dichotoma (L.) Vahl	September
F. lawiana (Beeck.) Kern.	July
F. miliacea (L.) Vahl.	September
F. tenera R. and S.	September
F. tetragona R. Br.	September
Rhinchoipora wightiana Steud.	September
Scirpus squarrosus L.	October
Scleria hebecarpa Nees	September

Poaceae :

Apluda mutica L.	September
Arundinelua pumila (Joechst) Steud.	September
Bambusa adrundinacea Willd.	
Brachiaria ramosa (L.) Stapf.	
Capillipedium huegelii (Hock.) Stapf.	September
Chloris virgata Sw.	September
Coix gigantea Koem. ex. Roxb	September
Dendrocalamus strictus Nees	July
Cichanthium annulalum (Forsk.) Stept	
Echinochlea colonum (L.) Link.	September
Eragrostis tenuifolia Hochst ex. Steud.	September
E. uniloides (Retz.) Nees ex Steud.	September
Eulalia trispicata Henr.	September-October
Hackelochlos granularis (L.) O. Ktze	September-October
Isachne globosa (*Thumb.*) O. Ktze	September
Ischaemum indicum (Houtt.) Merr.	September
I. rugosum Salis.	
Manisuris clarkei (Hack.) Bor apud Sant.	September
Ophiureus exaltatus O. Ktze.	September
Oplismenus burmanii (Retz.) Beauv.	September
O. compositus (L.) Beanv.	September
Panicum miliaceum L.	July—September
P. montanum Roxb.	September-October
Paspalum compactum Roth...	September
Paspalum flavidum (Retz.) Camus.	September
Pseudanthistiria heteroclita Hook. f.	
Setaria glauca Beauv.	July-September
S. verticillata Beauv.	September
Sorghum helepense Pers.	Sept-October
Spodiopogon rhizophorus (Steud.) Pilg.	September-October
Themeda quadrivalvis (L.) O. Ktze.	September
T. triandra Forsk.	September
Trilobachne cookei (Stapf.) Schrenc.	
Tripogon jacquemontii Stapf.	

Pteridophytes :

Adiantum philippense L.	
Aleuritopteris albomarginata (Cl.) Pan.	

A. farinosa (Forsk.) Fee.
Athyrium fillioemina (L.) Roth.
Microsorium membranaceum (Don.) Ching.

On the whole, the flora of Nasik District seems to suffer from extremes of rains during monsoons and extreme dryness for the rest of the year. There is not much moisture in the air nor water in the soil. Soils are often completely eroded from the hill slopes. But in river basins of Godavari, Girna and Darna, post-climax vegetation occurs here and there. Good cash crops like sugarcane, onion, chillies and cotton grow on black alluvial soils in plains.

6. FLORA OF AHMEDNAGAR DISTRICT

Ahmednagar district is close to Nasik, Sholapur, Thane and Pune. It is at a higher altitude than Pune. Like Sholapur a part of it lies in famine zone. The southern parts of Ahmednagar get a little rainfall, and that too eratically. The talukas of Ahmednagar, Parner, Shrigonda, Shevgaon, Pathardi and a part of Rahuri lie in the dry belt. As such, there is always uncertainty of rains, often low. Due to this Ahmednagar district is dry. It gets hardly 20″-22″ of rain and the number of rainy days is about 35-40. On the other hand, the north and the north-west region of Ahmednagar is better off, because of the proximity of Sahyadris and canal system fed by the Pravara river from a dam constructed at Bhandardara in Akola taluka. It supplies water continuously to Kopargaon, Shrirampur and a part of Rahuri. The forests are concentrated in Akola taluka which is at a higher altitude than Ahmednagar proper. A part of Parner, Rahuri, Pathardi, Shevgaon have small low hills. Close to Ahmednager also there are low hills which are a part of Baleshwar range. On a hill to the east there is a octangular tomb of Salabatkhan, popularly known as *Chandbibicha Mahal* which could be seen from 32 km. around. The hill is only about 200′ high above ground.

The whole hill is very dry. There are no trees except tamarind and *Mimusops hexandra* or khirni. In Pathardi taluka also there are small hills on which small shrubs and grasses grow, the exception being a few trees of *Semecarpus indicus*. Shevgaon has deep black cotton soil which produces a good crop of jowar, provided there are sufficient rains. There are many tiny bushes of *Zizyphus rugosa* and *Z. mauritiano Capparis aphylla*. Barring these, there are no conspicuous trees in the area.

To the west of Ahmednagar on way to Aurangabad, there is a small ghat at Jeur. On the hillock there are many plants of *Phoenix sylvestris*. On the low lying areas *Mangifera indica, Flacourtia ramontchi, Leea microphylla* grow. To the north of Ahmednagar there is a small valley between two small hills of Baleshwar range at Dongargaon. It is known as " Happy Valley ". A Shiva shrine and undergound water reservoirs make it very attractive. This hill also grows grass, as on the hill of Chandbibi Mahal, and looks green in rainy season, but dries up after the rainy season. This hill has only 4 or 5 kinds of trees.

The really significant vegetation of Ahmednagar district is in Akola taluka beyond Rajur. There is a ghat leading to Ghoti railway station on Bombay-Bhusawal route and forests along the crest line and in valleys. The overwhelming picture that emerges of vegetation of this district is of dry deciduous vegetation, scrub and open grasslands seen on so many low hills. This perhaps was not the case in the past, as could be seen

from the lists of fossil plants in Quaternary period given elsewhere in this book. However, the general picture is pockets of semievergreen or evergreen forests in certain places, especially in valleys in Akola having rich vegetation due to good rainfall, and scrub and deciduous forests over the other places, and seasonal open grasslands on low hills.

Considered as whole, the flora of Ahmednagar district is mostly xerophytic thorn savannah or scrub, or open grassland in many places, except in Akola taluka in the valleys near the main range of Sahyadris. It is evergreen in Harishchandragad ravines. But a little away from it at Rajur, there are only dry deciduous forests having poor quality teak, but many other forest products.

There is similarity between the xerophytic plants and vegetation of the three dry districts—Ahmednagar, Sholapur and a part of Pune, notwithstanding the varied nature of soil. The other districts of Western India do not show so much of similarity as regards the plants, vegetation and rainfall. The lower portion of Nasik district towards east also has the same vegetation, and also in parts of Beed, Aurangabad and Jalna districts in Marathwada. The vegetation of Vidarbha region is better, though essentially it is similar in character, *viz.*,dry deciduous forests. Exeception to this are the rich teak forests of Chandrapur.

The big rivers such as Godavari, Pravara, Mula and Sina drain the district south-eastwards.

Another peculiarity here is that there are some archaeological sites discovered on the banks of Pravara river at Jorwe, Newasa and further down on the banks of Godavari in Marathwada area having charred grains, seeds and dinosaurs. There are also Quaternary Leaf impression deposits on the banks of Pravara river at Sangamner and nearby areas.

The maximum rainfall recorded at Ahmednagar is 572.8 mm. The averge maximum temperature at Ahmednagar is 38.9°C and minimum is 11.7°C. July is the rainiest month and May the hottest. Humidity is generally low 20%, but in the rainy season it could be as high as 60-80%. The vegetation therefore, consists mostly of the dry deciduous type; the low hills have only scrub or open grass lands right from Ahmednagar to Madhi in Shevgaon taluka, and in Parner, Rahuri talukas. We shall, therefore, describe the plants and vegetation of four areas about which there is some information available: (1) Dongargaon or Happy Valley, (2) Sangamner, Chandanapuri Ghat and the areas of fossiliferrous Leaf Impression Beds, (3) Kotul and the living plants on the Travertine deposits, and (4) flora of Harishchandragad and vegetation of Dangi Hills. There are good pasture lands around Ahmednagar proper. They encourage lot of herdsmen to settle there during monsoons.

In Akola taluka there is sufficient vegetation. The high hill of Kalasubai is the highest point of Sahyadris (1646 m) in the Maharashtra State. Next to it not very far, is the Harishchandragad, the second highest point of Sahyadri in Maharashtra (1424 m.). At Rajur there is a forest of deciduous trees of *Tectona grandis*, *Terminalia chebula* and other deciduous species. Another place where there is some good vegetation is Kotul, a village in Akola. The river Mula rises from here, but falls immediately into a deep rocky valley beyond the waterfall at a place called Randha or Ranad. The annual rainfall at Kalasubai is nearly 250″-300″; at Kotul it is 150″; but at Rajur it is only 40″

The flora of Kotul has been worked out by Dr. D. R. Mahajan of Sangamner College. Barring these, the flora of no other place in Ahmednagar has been worked out.

The soils are basaltic and have poor capacity to hold water. The vegetation, therefore, is also poor. It is only at Harishchandragad that there is good forest in the valleys containing humid tropical evergreen species. The basalt is overlain by 2″-3″ of soil, at places 10″. The surface layer of soil, however, gets washed off or blown off by winds and cyclones in summer. We shall consider these separately.

6.1 : Plants of Dongargaon or " Happy Valley " :

About 20 km. north-west of Ahmednagar town, there is a small valley between two spurs of Sahyadris, easily approachable by road about 5 km. from Vambori Railway station on Daund-Manmad line at a place called Dongargaon. There are three underground water reserviors in the rocks, from which water trickles down all the time. Near them there is a Shiva temple. The place is barren, the soil being full of murum and pebbles. But with the advent of a few showers of monsoons, the place becomes green. Small Leguminous herbs and Compositae form a carpet. There are hardly 4-5 sparse tree species and 3-4 creepers. The rest are all herbs monsoon ephemerals (See list below). By about January the valley becomes brown and parched in May.

The flora of this place is xerophytic a dry scrub and a poor open grassland. It has not been worked out. Only Cooke (1901-1908) mentions some plants occurring here, mostly herbs which appear during rainy season. Wet rocks have some liverworts like *Riccia discolor*. On open ground there are some four-five remarkable plants-*Monsonia senegalensis*, *Crotalaria mysorensis*, *Phyllanthus scabrifolius*, *Clematis triloba*. The bushes of *Gymnosporia montana* and *Malva parviflora* occur scattered. A very remarkable feature of the flora here is the absence of any temperate plant, no doubt due to low elevation and rainfall, poor soil and the semi-arid environment. Seasonal grasses however appear to be regular feature. *Monsonia senegalensis* and *Clematis triloba* are remarkable plants of this place.

PLANTS OF DONGARGAON, DISTRICT AHMEDNAGAR (after Cooke)

Ranunculaceae :
Clematis triloba Heyne.

Anonaceae :
Anona squamosa L.
A. reticulata L.

Malvaceae :
Malva parviflora L.

Geraniaceae :
Monsonia senegalenis G. and P.

Celastraceae :
Gymnosporia montana Benth.

Papillionaceae :
Crotalaria filipes Benth.
C. mysorensis Roth

Compositae:
Lagasca mollis Cav.
Tridax procumbens L.

Convolvulaceae :
Ipomoea eriocarpa R. Br.

Scrophulariaceae :
Celsia coromandeliana Vahl.
Linaria ramosissima Br.

Scrophulariaceae :
Moniera cuneifolia Michx.

Acanthaceae :
Justicia simplex Den.

Verbenaceae :
Vitex negundo L.

Labiatae :
Leucas biflorus R. Br.

Nyctaginaceae :
Boerhaavia repanda Willd.

Amaranthaceae :
Amaranthus polyganus L
Pupalia lappaca Mog.

Santalaceae :
Santalum album L.

Euphorbiaceae :
Phyllanthus scabrifolius H. R.
Acalypha indica L.

Commelinaceae :
Commelina benghalensis L.

Graminaeae :
Panicum punctatum Burm.
Ophiurus corymbosus Goert.

6.2: Flora of Sangamner and fossiliferous leaf beds:

Sangamner is taluka place in Ahmednagar district lying at 19°.34′ N and 74° 16′E at the confluence of rivers Pravara and Mahalungi. In the vicinity of it there are four fossiliferous localities of Leaf Impression Beds belonging to Quaternary period, and one on the Chandanapuri Ghat leading to Pune. The vegetation of the place is interesting, in as much as, it shows great contrast with that in the past as seen in Leaf Beds. The flora of Chandanapuri Ghat is much similar to that of the ghats near Shivaneri, being dry and full of xerophytic plants.

It lies in the rain shadow. The two long mountain spurs of Sahyadris from its main range are extended from Akola taluka. The highest peak of Sahyadri, Kalasubai, lies in one of them. Of the two ranges one runs on southern side and the other on northern side. In between the two lie the valleys of Mula and Pravara rivers. The highest point in the northern range is Dudheshwar 2748′ high near the village Limbgaon Jali, 11 km north of Sangamner. The southern range is loftier, the

Baleshwar range. It rises to 3035′ high at Hivargaon. The valleys of Mula and Pravara rivers between these two ranges are fairly well wooded with mango and babhul trees, *Acacia arabica* and *A. leucophloea*, especially towards west. The soil on the river banks is rich alluvium. The northern part is not so well wooded. There are a number of streams which run in the direction of the Godavari to the east.

The soil is derived from the trap and often mixed with gravel. The country to the west side is mostly bare; but where there is depression and good soil, it is wooded with *Tectona grandis*. Since the main Sahyadri range runs to the north-west of Akola, close to Sangamner, one expects that Sangamner will have good rains, but the statistics show that quite reverse is the case. The rains are uncertain, very often untimely. The mean monthly rainfall known for the last 45 years from 1931—1976 is as follows :—

	(in millimetres)
January	5.69
February	0.19 to 0.26
March	1.5 to 1.60
April	6.3 to 6.5
May	17.90 to 18.76
June	89.73
July	92.01
August	56.71 to 58.80
September	136.71 to 138.80
October	58.82 to 64.32
November	36.14
December	3.03
Average annual rainfall ..	496.5

The region from Rajur to Sangamner lies in the rain shadow. Irrigation facility in Sangamner taluka is very limited. The soils are coarse and shallow; and, therefore, most of the vegetation around Sangamner is xerophytic. The fossiliferous leaf bed localities are : Modalwadi 22.4 km. north of Sangamner, Pimpalgaon Dhempa, Khadarmal and Khanderaowadi. They are also nearly at the same distance. The lists of living plants at these different localities are given separately. The living plants there now and those in fossils are not the same.

There are also archaeological sites at Jorwe near Sangamner and at Newase, from which the plants of archaeological period, especially the seeds have been discovered, and they are given in another Chapter. The list of plants today here shows that some plants such as *Ficus arnottiana*, *Ceiba malabarica* are similar to the ones that were present during late Pleistocene period, but not all. *Salix tetrasperma*, *Ranunculus sceleratus* found in fossils peat at Khanderaowadi are temperate plants, but in the vicinity of Sangamner there are no living temperate species except *Salix tetrasperma*. In the peat bed at Khanderaowadi we get also *Podocarpus* and *Betula* pollen grains. Both these plants are entirely lacking in the present flora of Sangamner, as well as in the whole of Maharashtra. They have certainly migrated from this area elsewhere. Most of the

living plants here grow on rocky soils or gravel, and they support only open grasslands and shrubs. The different beds of fossilised plants evolved as follows :—

1. Basal hard Traps : depth not known.

2. Intermediate Trap layers

3. Flora represented by pollen grains in fossil peat lens pockets found at Khanderaowadi : age approximately, 2300—2600 years.

4. Flora of Leaf Beds around Sangamner : in fossiliferous localities Modalwadi etc.

5. Flora of archaeological sites Jorwe and Newase on the bank of Pravara river : age approximately 2000 years.

6. Modern Flora around Sangamner xerophytic scrub and open seasonal grasslands.

The flora in other similar places in Maharashtra might have passed through similar serial stages leading to dry deciduous vegetation.

6.3 : Plants growing on leaf-bed localities :

The first Late Quaternary fossiliferous locality near Sangamner is Modalwadi.

It is 22.4 km. on Sangamner-Sakur road at 33.6 km. there is another locality called Pimpalgaon Dhempa. The plants found at these localities are given below :—

I. *Locality—Modalwadi* near Pimpalgaon Dhempa.

(1) Living Plants found —

Papaveraceae :
Argemone mexicana L.

Capparidaceae :
Cleome viscosa L.
C. simplicifolia Hook.

Portulacaceae :
Portulaca oleracea L.

Malvaceae :
Sida veronicifolia Lamk.
Abutilon indicum Sweet.

Vitaceae :
Leea macrophylla L.

Anacardiaceae :
Rhus mysorensis Heijne.

Papilionaceae :
Dalbergia melanoxylon Guill.

Mimosaceae :
Acacia arabica Willd.

Rubiaceae :
Morinda citrifolia L.

Acanthaceae :
Barleria cristata L.

Urticaceae :
Ficus bengalensis L.

(?) Plants found in the Valley at Modalwadi —

Filices :
Adiantum capillusveneris L.
Actinopteris dichotoma Bedd.
Pteris longifolia L.

Bombacaceae :
Salmalia malabaricum DC.

Zygophyllaceae :
Tribulus terrestris L.

Rutaceae :
Feronia elephantum Corren.

Meliaceae :
Azadirachta indica A. Juss.

Rhamnaceae :
Zizyphus jujuba Lamk.

Anacardiaceae :
Rhus mysurensis Heyne.

Caesalpiniaceae :
Cassia fistula L.
C. auriculata L.

Mimosaceae :
Acacia arabica Willd.

Combretaceae :
Combretum ovalifolium Roxb.

Lythraceae :
Woodfordia fruticosa Salisb.

Compositae :
Ageratum conyzoides L.
Xanthium strumarium L.
Tridax procumbens L.

Apocynaceae :
Carissa carandas L.

Asclepiadaceae :
Calotropis gigantea R. Br.
Asclepias curasavica L.

Solanaceae :
Solanum nigrum L.

Acanthaceae :
Barleria cristata L.

Verbenaceae :
Lantana camara Moldenke
Vitex negundo L.

Amaranthaceae :
Amaranthus spinous L.
Achyranthus aspera L.

Polygonaceae :
Polygonum glabrum Willd.

Loranthaceae :
Viscum articulatum Burm.

Euphorbiaceae :
Euphorbia antiquorum L.
E. tirucalli L.
E. hirta L.
Bridelia retusa Spreng.

Urticaceae :
Ficus bengalensis L.
F. arnottiana Mig.
F. glomerata Roxb.

Salicaceae :
Salix tetrasperma Roxb.

Gramineae :
Setaria glauca Beauv.

The second locality from which fossil material is available is Khanderaowadi. Here the Leaf Bed lies along the river bank. It is over 3 km to the east from the village of the same name. The Leaf Bed is on a flat top near the hill from where apparently the streams were flowing in the past. The vegetation around this locality is of dry and mixed deciduous type. The plants found are given below. It is close to Chandanapuri Ghat. The terrain on which Leaf Bed occurs is undulating; the fossil plants are scattered on the hill top which is flat. Peat also was found deep down in the valley here.

II. Locality—Khanderaowadi

(i) The locality is undulating. The plants found on the flat top of the hills are —

Capparidaceae :
Cleome simplicifolia Hook.
Gynandropsis gynandra DC.
Capparis aphylla Roth.

Malvaceae :
Malva parviflora L.

Rutaceae :
Ruta graveolens Grah.

Meliaceae :
Melia azadirach L.
Azadirachta indica Juss.

Rhamnaceae :
Zizyphus jujuba Lam.

Anacardiacaceae :
Rhus mysurensis Heyne.
Odina woodier Roxb.

Papilionaceae :
Butea monosperma Koenig.

Caesalpiniaceae :
Caesalpinia bonducella Flem.
Parkinsonia aculeata L.
Cassia auriculata L.

Combretaceae :
Terminalia arjuna W. and A.

Lythraceae :
Ammannia floribunda Clarke.
Woodfordia fruticosa Salisb.

Ebenaceae :
Diospyros embryopteris Pers.

Verbenaceae :
Vitex negundo L.

Graminae :

20 different kinds of grasses occur here.

(ii) Down the valley at Khanderaowadi the following plants are found :—

Filices :
Pteris longifolia L.

Malvaceae :
Abutilon indicum Sweet.

Rubiaceae :
Adina cordifolia Benth. and Hook.

Compositae :
Lagasca mollis Cav.

Plumbaginaceae :
Vogelia indica Gibs.

Apocynaceae :
Carissa congesta

Asclepiadeceae :
Hoya carnosa Br.

Solanaceae :
Solanum xanthocarpum Schd.

Pedaliaceae :
Martynia diandra Clox.

Acanthaceae :
Lepidagathis cristata Willd.
Justicia diffusa Willd.

Verbenaceae :
Lantana camara L.
Tectona grandis L.

Labiatae :
Leucas aspera Spr.

Euphorbiaceae :
Euphorbia antiquorum L.

Urticaceae :
Ficus arnottiana Mig.
F. glomerata Roxb.

Commelinaceae :
Commelina bengalensis L.

Cyperaceae :
Cyperus rotundus L.

Graminae :
Setaria tomentosa Kunth.
Eleusine indica Gaertn.
Bambusa arundo Kalein.

The third locality is Nandur Khandarmal. This locality lies in a valley which is 28 km. from Sangamner on Sangamner-Pune Road. The locality is about 1.6 km to the east from Nandur Khandarmal village. The living plants found here are mentioned below. There is a valley by the side of the road in which also several plants are found. The vegetation is a mixture of xerophytic shrubs, herbs and deciduous trees.

III. Locality—Nandur Khandarmal

(i) Plants found on the top flat —

Ranunculaceae :
Clematis gouriana Roxb.

Papaveraceae :
Argemone mexicana L.

Portulacaceae :
Portulaca oleracea L.

Malvaceae :
Sida cordifolia L.
Abutilon indicum Sweet.

Rutaceae :
Aegle marmelos Corr.

Vitaceae :
Leea macrophylla Roxb.

Anacardiaceae :
Mangifera indica L.

Papilionaceae :
Butea monosperma Koenig.
Dalbergia latifolia Roxb.
Pongamia glabra Vent.

Mimoseae :
Prosopis spicigera L.
Acacia suma Kurz.
A. arabica Willd.
Albizzia lebbek Benth.

Lythaaceae :
Lagerstroemia parviflora Roxb.

Apocynaceae :
Carissa carandas L.
—*C. congesta*

Verbenaceae :
Lantana camara L.
Vitex negundo L.

Labiatae :
Pogostemon paniculatus Benth.

Amaranthaceae :
Celosia argentea L.

Urticaceae :
Ficus glomerata Roxb.
F. *religiosa* L.

Salicaceae :
Tamarix eriocoides Rottl.

Graminae :
Eleusine coranara Gaert.
Cynodon dactylon Pers.
and many other grasses.

(ii) In the valley by the side of the road going to Nandur Khandarmal the following plants grow :—

Filices :
Actinopteris dichotoma Forsk.
Pteris longifolia L.
Cheilanthes farinosa Kaulf.

Rutaceae :
Aegle marmelos Corr.

Meliaceae :
Azadirachta indica Juss.

Rhamnaceae :
Zizyphus jujuba Lamk.

Anacardiaceae :
Rhus mysurensis Heyne.

Papilionaceae :
Butea monosperma Koenig.

Caesalpiniaceae :
Caesalpinia bonducella Flem.
Cassia auriculata L.

Mimoceae :
Acacia arabica Willd.
Albizzia lebbek Benth.

Compositae :
Lagasca mollis Cav.
Artemessia vulgaris Clarke.
Echinops echinatus Roxb.
Parthenium histerophorus L.

Apocynaceae :
Nerium indicum Mill.

Verbenaceae :
Tectona grandis L.

Urticaceae :
Ficus religiosa L.
F. glomerata Roxb.

Palmae :
Phoenix sylvestris Roxb.

All these lists when compared with those of fossil plants which are elsewhere given will show that ancient plants here were different from those living at present and the vegetation seems to have changed through successive periods to the dry deciduous one at present from moist cold deciduous stage.

6.4 : Flora of Chandanapuri Ghat :

Chandanapuri is a village at the foot of the ghat of the same name on Sangamner-Pune road, about 15 km. from Sangamner. It is a dry place. The ghat section is about 3 km. Much of its flora is in its lower region. The upper portion has very few shrubs or bushes, mostly pteridophytes. Some of the plants listed below do not occur on the top region towards Narayangaon, or in other dry ghats. There is only a scrub or thorn savannah formed by bushes of *Gymnosporia montana*, *Euphorbia antiquorum* and *Vogelia indica* which is a rare plant of Plumbaginaceae and *Rhus mysorensis* *Withania sommifera* also occurs but generally in lower region where soil has some moisture. It grows to a height of an undershrub and has much large leaves; possibly it is a distinct cytoecotype. The plant is highly medicinal and deserves to be studied for its alkaloid content and autoecology. *Diospyros embryopteris* and *Tamarix dioica* occur in the lower reaches, but are not common. *Carissa congesta*, *Asparagus racemosus* occur here, as in Shivaneri Ghat and dry hills like Vetal near Pune and on other hills in Maharashtra. *Ficus arnottiana* occurs in rocky ledges but is not at all common. The rainfall in this region being low and rocks being hard, trees are stunted. But possibly it was not so in the distant past as this species is generally found in the ghats with high rainfall. It is also found in the fossil leaf beds here.

The plants found here are given below :—

Ranunculaceae :
Ranunculus scleratus L.

Anonaceae :
Anona squamosa L.

Capparidaceae :
Capparis aphylla Roth.

Tamaricaceae :
Tamarix dioica Roxb.

Rhamnaceae :
Zizyphus rugosa Lam.

Vitaceae :
Leea macrophylla Roxb.

Anacardiaceae :
Mangifera indica L.
Rhus mysurensis Heyne.
Odina woodier Roxb.

Papilionaceae :
Pongamia glabra Vent.

Mimoceae :
Prosopis spicignera L.
Acacia arabica Willd.

Combretaceae :
Combretum ovalifolium Roxb.

Myrtaceae :
Psidium guava L.

Lythraceae :
Woodfordia fruticosa Salisb.

Plumbaginaceae :
Vogelia indica Gibs.

Apocynaceae :
Carissa congesta Wight.

Asclepiadaceae :
Calotropis gigantea Br.

Solanaceae :
Solanum xanthocarpum Schd.
Withania somniferum Dun.
Datura stramonium L.

Verbenaceae :
Lantana camara L.

Euphorbiaceae :
Euphorbia nerifolia.
E. antiquorum L.
E. tirucalli L.
Phyllanthus emblica L.
Putranjiva roxburghii Wall.
Ricinus communis L.

Urticaceae :
Ficus religiosa L.
F. glomerata Roxb.
F. arnotiana Mig.
F. bengalensis L.

Salicaceae :
Salix tetrasperma Roxb.

Musaceae :
Musa superba Roxb.

Amaryllidaceae :
Agave americana L.

Liliaceae :
Asparagus racemosus Willd. var. *javanica* Baker.
Scilla indica Roxb.
Aloe vera L.

Palmae :
Phoenix sylvestris Roxb.

Graminae :
Pennisetum typhoideum Rich.
Setaria plicata Cooke.
S. glauca Beauv.
Dendrocalamus strictus Nees.

(ii) There is a waterfall here running from top to narrow valley down, about 125 feet. The plants found near the waterfall are —

Filices :
Actinopteris dichotoma Forsk.
Adiantum capillus veneris L.
A. lunulatum Burm.
Pteris longifolia Bedd.

Umbelliferae :
Centella asiatica L.

Hydrocharitaceae :
Hydrilla verticillata Presl
Vallisneria spiralis L.
Ottelia alsinoides Pers.

Pontederiaceae :
Eichornia crassipes Solsm.

Pandanaceae :
Pandanus tectorius L.

Araceae :
Pistia stratiotes L.
Pothos scandens L.

Naiadaceae :
Potamogeton indicum Roxb.

6·5 : Flora of Kotul and Kotuleshwar Temple area :

Kotul in Akola taluka is about 41.6 km from Sangamner and lies on high rocky plateau from where the river Mula rises going towards Mula-nagar and Rahuri. The place is full of rocks containing numerous quartz veins, Chalcedony, agates, colourful quartz crystals or colourless ones in the veins. There is plenty of lime, and lime dust in the neighbourhood and it gets spread all over, and accumulates in the area along the streams and cascades. The rainfall is 40″ or more and there is forest all around in the valley. The streams, and acidified water from surrounding debris dissolve thick lime dust and also calcite (plentiful here), and gives rise to travertine deposits along Mula river. They are in the form of caves. Calceolus plants grow on them, river bank and around the Kotuleshwar temple. There are 2-3 large travertine caves near the temple. There is forest along the banks of Mula; but the most interesting plants are found on travertine tops and some lie embedded in the travertine tufa near a place called Sahasradhara. The situation here is somewhat similar to the Sahasradhara stream near Dehradun in Uttar Pradesh. There are many tiny concretions on the roof of a cave. They owe their origin to highly calcarious waters trikling down from the roof of a cave. These deposits are full of calcium, more than 90% and the rest 10% dust and earth. The tufa which forms the travertine is derived from the calcite rich area around.

Travertine deposits here contain 14 fossil diadoms, about 6 members of Myxopyhceae, and a calceolus Pottiaceous moss, *Anectangium stachyanum* Mitt. G. (Mahajan, 1978) in Ph. D. Thesis. These are described in the Chapter on fossil plants of Maharashtra.

There is a valley below the Kotuleshwar temple, through which the river Mula flows. On the plateau at top there are a number of herbs and ephemerals. In the valley *Tectona grandis, Anogeissus latifolia, Terminalia chebula, T. bellerica, T. crenulata, T. tomentosa* grow. The growth of *Tectona grandis,* however, is not prolific. The forest here, therefore, is not known for good teak as for other forest products such as gum arabic, myrobalans from *T. chebula,* gum resin from *Boswellia serrata,* Bidi leaves of *Tendu* or *Dospyros embryopteris, Katha* or Kutch from *Acacia catechu,* fruits of Amla or *Phyllanthus emblica.* Rosha grass, medicinal plants like *Mentha viridis* grow plentiful along streams and also some fragrant Compositae and Labiateae. In crevices of rocks *Musa superba* grows in number of places. These plant products are obtained in large quantities.

There are many secondary species in forests here like *Butea monosperma, Bridelia retusa, Mundulea suberosa* on dry slopes. In moist areas on rocks *Hydrocotyle asiatica* and other water loving herbs. *Cyperi* and grasses grow abundantly; on calcareous soils, on rocks *Ficus glomerata, Ficus arnottiana,* some ferns are noticed. Due to such plants the vegetation here looks more green than at many other places. The lists of plants around Kotul and Kotuleshwar temple and along the Mula river bed are as below :—

I. Pteridophytes :
Selaginella reticulata.
Adiantum capillus-veneris.
A. caudatum L.
A. lunulatum Burm.
Pteris longifolia Bedd.
Cheilanthes farinosa Kaulf.
C. rufa Don.

Flowering plants

Compositae :
Caesulia axillaris Roxb.

Acanthaceae :
Justicia diffusa Willd.
J. coromandeliana var. *malabarica* Willd.

II. The plants found on top of the Travertine dome :

Papaveraceae :
Argemone mexicana L.

Lythraceae :
Woodfordia fruticosa Salisb.

Compositae :
Ageratum conyzoides L.
Xanthium strumarium L.
Tridax procumbens L.
Sonchus arvensis L.

Verbenaceae :
Lantana camara var. *aculeata* Moldenke.
L. indica Roxb.
Duranta plumeri Jacq.
Vitex negundo L.

Labiatae :
Ocimum americana L.
Pogostemon heyneanus Benth.

III. Kotuleshwar temple area :

Anonaceae :
Anona reticulata L.
A. squanosa L.

Meliaceae :
Azadirachta indica A. Juss.

Caesalpiniaceae :
Tamarindus indica L.

Mimoseae :
Acacia arabica Willd.

Apocynaceae :
Plumeria acutifolia Por.
P. rubra L.
Vinca rosea L.

Scrophulariaceae :
Striga alba Benth.

Urticaceae :
Ficus glomerata Roxb.

Ameryllidaceae :
Pancratium asiaticum L.
Artabotrys odoratissimus Br.

IV. Plants found along the river banks of Mula :

Compositae :
Ageratum conyzoides L.

Amaryllidaceae :
Agave americana L.

Araceae :
Amorphophallus commutatus Engler.
Colocasia antiquorum Schott.

Cyperaceae :
Cyperus rotundus L.

Menispermaceae :
Tinospora cordifolia Miers.

Capparidaceae :
Capparis aphylla Roth.

Malvaceae :
Sida veronic ifolia Lamk.
Abutilon ind icum Sweet.

Rhamnaceae :
Zizyphus jujuba Lamk.

Mimoseae :
Acacia arabica Willd.

Asclepiadaceae :
Asclepias curasavica L.

Compositae :
Caesulia axillaris Roxb.

Polygonaceae :
Polygonum glabrum Willd.

Euphorbiaceae :
Euphorbia spelendens Boj.
E. antiquorum L.

Pandanaceae :
Pandanus odoratissimus L.

Cyperaceae :
Cyperus rotandus L.

V. Plants found in the bed of river Mula :

Nymphaeaceae :
Nymphaea pubescens Willd.

Hydrocharitaceae :
Ottelia alismoides Pers.
Vallisneria spiralis L.
Hydrilla verticillata Pers.

Zingiberaceae :
Hedychium coronarium Koening.

Pontederiaceae :
Eichornia crassipes Solms.

Lemnaceae :
Lemna polyrhiza L.

Naiadaceae :
Potamogeton crispus L.

None of these plants occur in tufa or on travertine tops or in it.

6·6 : Flora of Harishchandragad :

The three places rich in vegetation, Harishchandragad, Kalasubai and Kotul, are in Akola taluka. The vegetation of Rajur is typically dry deciduous, but that of Harishchandragad is unique in as much as it has some remnants of evergreen and semi-evergreen species, in pockets of vegetation in ravines on the sunny side. The other side is a steep rock wall facing full blast of SW monsoons. The flat platforms on the crests have thorny bushes forming scrub, and numerous monsoon ephemerals, grasses and legumes. They also contain a few temperate species.

Harishchandragad area lies at the intersection of four districts, Thane, Pune, Ahmednagar and Nasik. It is almost inaccessible during rains and has numerous reptiles. There is a dilapidated fort on the top and a Kedarnath temple. The mount is formed by 10-12 consolidated lava flows and there are some caves and underground water reservoirs in the intertraps as on Sinhagad or in Mahabaleshwar Ghat. There are flat platforms on 2-3 high peaks. There is a ghat on Peint side known as Sadrya ghat and one on Akola side going to Ghoti railway station on the Central Railway. On the top of the fort there is, a *balekilla*, known as Taramaticha Dongar. South-west side of the fort is fully exposed to rains and winds. It gets about 200-250" of rainfall. Maximum rainfall is in July-August. After the rains the place dries up and looks brown and barren in April-May. The daily temperatures are the lowest in the month of January and the highest in the month of May.

Vegetations.—The vegetation of this place was not studied earlier, nor any botanists have visited this place except perhaps Dalzell. It was studied only recently by K. V. Billore and K. Hemadri (1969) and by V. D. Vartak (1971). Billore and Hemadri collected plants from April to November. They collected 330 species of flowering plants spread over 245 genera and 87 families (see list given below).

Harishchandragad can be approached from Murbad in Thane district, from Akola in Ahmednagar district or from Peint in Nasik district for studying the vegetation. The vegetation of Sadrya ghat consists of some deciduous and some semi-evergreen species such as *Terminalia crenulata, Wrightia tinctoria, Lagerstroemia parviflora, Madhuca longifolia, Bombax ceiba, Adina cordifolia, Xeromorphis spinosa, Schrebera oleosa*, bushes of *Carissa congesta and* shrubs of *Eranthemum purpuresens.* They are mixed with species of *Blumea, Ecbolium viridis, Anisomelis boumontsia* and *Centratherum phyllolaeanum.*

Other important trees here are *Ixora brachiata, Carallia brachiata, Bridelia squamosa,* not forming a community, but growing here and there. In ravines and on shady slopes at higher level, *Sterculia guttata, Heterophragma quadriloculare, Grewia tilaefolia, Atlantia racemosa, Putranjiva roxbourghii, Albizzia amara* are common. The ecological range of the last named species *viz.*, *Albizzida amara* is rather interesting and has been studied by Meher-Homji of French Institute, Pondichery. A very remarkable feature of the vegetation here is the absence of *Tectona grandis* which is a typical tree of deciduous forests. Only 16-19 km. away from this place at Rajur to the east, it is abundant. Apparently it does not seem to tolerate heavy rains and needs some resting dry period like winter and summer.

Many climbers especially *Ventilago bombaiensis* are found at the foot of the hill, in ghat and on open slopes. Side by side with them *Anisomeles heyneana bushes* and *Vicoa cernua, Blumea belangeriana* grow in plenty and form undergrowth.

At the foot of Pachnai plateau on way to the Gad there are scattered strands or patches of *Memecylon umbellatum, Terminallia chebula, Canthium dicocum, Mallotus philippinensis, Xantholis tomentosa, Heterophragma quadrangulare, Lagerstroemia lanceolaris, Cassia fistula.* Shrubs of *Pavetta concanica, Gymnosporia rothiana, Carissa congesta, Leea indica, Lobelia nicotianaefolia* etc. grow on the outskirts of forests.

On the lower hill slopes of Kedarnath and on slopes of Taramaticha Dongar, there are typical semi-evergreen plants viz., *Memecylon umbellatum*, *Ligustrum perotteti*, *Olea dioeca*, *Actinodaphne angustifolia*, *Glochidion hohenackeri*, *Syzygium cumini*, *Litsea zeylanica*, *Atlantia racemosa*, *Symplocos beddomei*. They are more concentrated in the valley at lower level than here on the plateaux below the top. There is plenty of undergrowth formed by *Thelepaepale exocephala*. A few shrubs of *Osyris wightiana*, *Gymnosporia rothiana*, *Elaeagnus conferta*, *Acacia torta*, *Jasminum malabaricum* are very common.

The rainfall here, more so in valleys, being very heavy, the trees are covered with mosses densely and by orchids like *Aerides crispum*, *Dendrobium herbaceum* and by *Viscum articulatum*.

On the open tableland around Kedarnath temple and Taramaticha Dongar, there are many herbaceous plants and some isolated clumps of *Euphorbia neriifolia*, *Ligustrum perotteti*, *Tricholepis amplexicaulis*, *Vernonia divergens*, *Clematis wightiana* (rather rare), *Rubia cordifolia*. Species of ground orchid *Habenaria*, *Nilgirianthus reticulatus* and strands of big grass *Heteropogon triticaceous* are met with.

The herbaceous flora on top platforms consists of monsoon ephemerals, *Alysicarpus belagaumensis*, *Smithia stocksii*. In moist and water-logged situations *Hygrophila serpyllum* *Dysophylla stellata*, *Habenaria gibsonii*. *Eriocaulon indica* are found.

On wet rocks lithophytes and two species of the rare family Podostemaceae. *Terniola zeylanica* and *Dicrea dichotoma*, are found. They are rather interesting plants of running streams, but get dried up as soon as the streams cease to have water.

Thus the flora is a curious mixture of relict tropical evergreen types in ravines or semi-evergreen ones in valleys, herbaceous monsoon ephemerals on top platforms, bushes and drier species on the lower slopes and in Sadrya ghat. They slowly merge into deciduous species towards Rajur, but having moist species towards Peint and having practically no vegetation except grasses towards Konkankada scarp. As Harishchandragad is adjacent to Peint (Nasik) and Thane forests, it shows considerable resemblance with both of them. Its vegetation in drier areas is similar to that of Junnar ghats and that on top of Shivaneri fort. It becomes progressively made up of drier species as one proceeds towards Chandanapuri Ghat in Sangamner taluka. But the vegetation at higher slopes and on top flats reminds one of the species seen on the Matheran plateau except the evergreen members like *Garcinia* species which are not here.

Harishchandragad is surrounded by other hills and hill forts like Aundha-Patta fort Ratangad etc. The flora of these hills and forts and the hill peaks has been studied by V. D. Vartak (1970) which is considered next.

List of Plants of Harishchandragad
(after Billore and Hemadri 1969)

Ranunculaceae :
Clematis hedysarifolia DC.
C. wightiana Wall. ex Wt. and Arn.
Thalictrum dalzellii Hk.

Anonaceae :
Miliusa tomentosa (Roxb.) Sinclair

Menispermeaceae :
Cyclea peltata (Lamk.) N.K.f. and Thoms.
Stephania japonica (Thunb.) Miers.

Papaveraceae :
Argemone mexicana Linn.

Cleomaceae :
Cleome gynandra Linn.

Capparidaceae :
Capparis rotundifolia Rottl.
C. spinosa Linn.

Flacourtiaceae :
Flacourtia indica (Brum f.) Merr.

Caryophyllaceae :
Polycarpon prostratum (Forsk.) Asch. and Schw.

Portulacaceae :
Portulaca oleracea Linn.

Malvaceae :
Abelmoschus manihot (Linn.) Medic. SSp. *tetraphyllus* (Roxb. Ex. Hernem.) Borss. var. *megaspermus* Hemadri var. nov.
Aubtilon sersicus (Burm. f.) Merr.
Hibiscus hirsutus Linn. (*N. albotii* Rakshit).
Sida cordata (Burm. f.) Pors.
S. mysurensis Wt. and Arn.
S. rhombifolia Linn.

Bombacaceae :
Bombax ceiba Linn.

Sterculiaceae :
Streculia guttata Roxb.

Tiliaceae :
Grewia tiliaefolia Vahl. var. *leptopetala* (Brandis) Cooke.
Triumfetta annua Linn.
T. rhomboidea Jacq.

Linaceae ;
Linum mysrense Heyne ex Benth. apud. Lindl.

Balsaminaceae :
Impatiens balsamina Linn. var. *rosea* Linel.
Impatiens pusilla Heyne

Rutaceae :
Atlantia racemosa Wt. and Arn.
Murraya koenigii (Linn.) Spreng.
M. paniculata (Linn.) Jack.
Amoora lawii (Wt.) Bedd.

Celastraceae :
Celastrus paniculatus Willd.
Gymnosporia rothiana (Wt. and Arn.) Laws.

Rhamnaceae :
Ventilago bombaiensis Dalz.
Zizyphus rugosa Lamk.

Leeaceae :
Leea indica (Burm. f.) Merr.
L. robusta Roxb.

Vitaceae :
Cayratia elongata (Roxb.) Suess.
C. repanda Vahl.

Sapindaceae :
Schleichera oleosa (Lour.) Oken.

Anacardiaceae :
Mangifera indica Linn.

Fabaceae :
Alysicarpus belgaumensis Wt.
Atylosia lineata Wt. and Arn.
Crotalaria filipes Bentn.
C. leptostachya Benth.
C. retusa Linn.
C. triquetra Datz.
Cylista scariosa Roxb.
Desmodium rotundifolium Baker.
Erythrina stricta Roxb.
Indigofera trita Linn.
Moghania strobilifera (Linn.) st. Hil. ex Jecks.
Nogra simplicifolia (Dalz) Raizada
Phaseolus sublobatus Roxb.
Smithia bigemina Dalz.
S. hirsuta Dalz.
S. purpurea Hook.
S. setulosa Dalz.
Teramnus labialis (Linn. f.) Spreng.
Vigna vexillata Linn.

Caesalpiniaceae :
Bauhinia racemosa Lamk.
Cassia fistula Linn.

Mimosaceae :
Acacia torta (Roxb.) Craib.
Albizzia odoratissima (Linn. f.) Benth.

Crassulaceae :
Kalanchoe pinnata (Lamk.) Pers.

Combretaceae :
Terminalia bellerica (Breyn ex Gaartn.) Roxb.
Terminalia chebula Retz.
T. crenulata Rath.

Rhizophoraceae :
Carallia brachiata (Lour.) Merr.

Myrtaceae :
Syzygium cumini (Linn.) Skeels.

Melastomaceae :
Memecylon umbellatum Burm. f.

Lythraceae :
Ammannia baccifera Linn.
Lagerstroemia microcarpa Wt. (*L. lanceolata* Wall ex Wt. and Arn.)
L. parviflora Roxb.
Rotala densiflora (Roxb.) Koehne.
R. serpyllifolia (Roxb.) Bremek.
Woodfordia fruticosa (Linn.) Kurz.

Samydaceae :
Casearia graveolens Dalz.

Cucurbitaceae :
Discospermum ritchici Cl.

Molluginaceae :
Glinus lotoides (Linn.) Loefl.

Apiaceae :
Heracleum pinda Dalz.
Peucedanum grande Cl.
Pimpinella adscendens Dalz.
P. heyneana Wall.
P. monoica Dalz.
Trachyspermum stictocarpum (Cl.) Wolff.

Rubiaceae :
Adina cordifolia Hook. f. ex. Brandis.
Canthium dicoccum var. *umbellatum* (Gamble) Sant.
Dentillana corymbosa (Willd.) Kuntze.
Ixora brachiata Roxb.
Mitragyna parvifolia (Roxb.) Korth
Anotis calycina (Wall. ex Hook. f.) Lewis.
A. lancifolia (Hook. f.) Lewis
Oldenlandia corymbosa Linn.
O. maheshwarii Sant, and Merch.
Pavetta concana Bremek.
Rubia cordifolia Linn.
Spermadictyon suaveolens Roxb.
Wendlandia heynei (R. and S.) Sant and Merch.
Xeromphis spinosa (Tkunb.) Keay.

Asteraceae :
Ageratum conyzoides Linn.
Bidens biternata (Lour.) Merr. et Scherff.
Blumea belongeriana DC.
B. eriantha DC.
B. malcolmii (Cl.) Hook. f.
B. membranacea DC.
B. oxyodonta DC.
B. salidaginoides (Poir.) DC.
Caesulia axillaris Roxb.
Centratherum phyllolaenum (DC.) Benth. Ex. Cl.
C. tenue (Wt.) Cl.
Conyza leucantha (D. Don) Ludlow and Raven.
C. stricta Willd.
Cyathocline lutea Law. ex Wight.
C. purpurea (Don.) Ktge.
Eclipta prostrata (Linn.) Linn.
Emilia sonchifolia (Linn.) DC.
Gnaphalium indicum Linn.

Gynura cusimbusa (D. Don) S. Morre.
Lamprachaenium microcephalum (Dalz.) Benth.
Senecio dalzellii Cl.
S. grahami Hook. f.
Sphaeranthus indicus Linn.
Tricholepis amplexicaulis Cl.
Vernonia divergens (Roxb.) Edgw.
Vicoa cernua Dalz.

Lobeliaceae :
Lobelia alsinoides Lamk.
L. nicotianaefolia Heyne.

Campanulaceae :
Wahlenbergia marginata (Thunb.) A. DC.

Primulaceae:
Anagallis pumila Swartz

Myrsinaceae :
Embelia tsjeriam cattam A. DC.

Sapotaceae :
Madhuca longifolia (Koen.) mac Bride var. *latifolia* (Roxb.) Chev.
Xantolis tomentosa (Roxb.) Raf.

Symplocaceae :
Symplocos beddomei Cl.

Oleaceae :
Jasminum malabaricum Wt.
Ligustrum perrottetii A. DC.
Olea dioica Roxb.
Schrebera swietenioides Roxb.

Apocynaceae :
Carissa congesta Wt.
Wrightia tinctoria R. Br.

Asclepiadaceae :
Cyanchum callialata Hem.
Gymnena sylvestris (Retz.) R. Br. ex Schult.
Tylophora dalzellii Hook. f.

Periplocaceae :
Hemidesmus indicus Schultes

Gentianaceae :
Canscora difusa (Vahl.) R. Br. ex R. and S.
Centaurium centaurioides (Roxb.) Rolla Rao et.
Swertia corymbosa var. *lawii* C. B. Cl.
S. minor (Griseb.) Knobl.

Boraginaceae :
Adelocaryum coelestinum (Lindl.) Brand.
Cordia dichotoma Forest. f.
Paracaryum malabaricum C. B. Cl.

Convolvulaceae :
Argyreia strigosa (Roth.) Sant. et Patel.
Porana racemosa Grah.

Cuscutaceae :
Cuscuta reflexa Roxb.

Solanaceae :
Solanum nigrum Linn.
S. indicum Linn.

Scrophulariaceae :
Buchnera hispida Buch-Ham.
Lindernia parviflora (Roxb.) Haines
Rhamphicarpa longiflora (Arn.) Benth.
Sopubia delphinifolia (Roxb.) G. Don.
Striga asiatica (Linn.) Kuntze var. *asiatica.*
S. gesnerioides (Willd.) Vatke.
Rungia pectinata (Linn.) Nees.
Thelepaepale ixiocephala (Benth.) Bremek.

Verbenaceae :
Callicarpa tomentosa (Linn.) Murray.
Vitex negundo Linn.

Lamiaceae :
Anisomeles heyneana Benth.
Colebrookea oppositifolia Smith.
Dysophylla stellata Benth.
Leucas ciliata Wall. ex Benth.
L. lavandulaefolia Rees.
L. stelligera Wall. ex Benth.
Nepeta hindustana (Heyne ex Roth) Haines var. *woodrowii* Sant.
Plectranthus mollis (Ait.) Spreng.
P. stocksii Hook. f.
Pogostemon plectranthoides Desf.
P. purpurascens Dalz.
Salvia plebeia R. Br.

Amaranthaceae :
Achyranthus aspera Linn. var. *porphyristachya* Hook. f.
Aerrua sanguinolenta (Linn.) Bl.
Alternanthera sessilis (Linn.) DC.
Amaranthus hybridus Linn. SSp. *cruentus* Thell. var. *paniculatus* Thell.
A. lividus Linn. SSp. *polygonoides* (Moq.) Probst.
A. spinosus Linn.
Celosia argentea Linn.

Chenopodiaceae :
Chenopodium album Linn.
C. murale Linn.

Polygonaceae :
Polygonum chinense Linn.
P. glabrum Willd.
P. plebejum R. Br.

Podostemaceae :
Dicraea dichotoma (Gardn.) Tul.
Terniola zeylanica Tul. var. *konkanica* (Willis) Sant.

Piperaceae :
Piper trichostachyon (Mig.) C. DC.

Lauraceae :
Actinodaphne angustifolia Nees.
Listea zeylanica Nees.

Thymelaeaceae :
Lasiosiphon eriocephalus (Gr.) Decne.

Elaeagnaceae :
Elaeagnus conferta Roxb.

Loranthaceae :
Dendrophthoe falcata Etting var. *coccinea* Talb.
Macrosolen capitellatus (Wt. and Arn.) Danser.
Viscum angulatus Heyne ex DC.

Santalaceae :
Osyris wightiana Wall. ex Wight.

Euphorbaceae :
Bridelia squamosa Gehrm.
Embelia officinalis Gaertn.
Euphorbia torta Linn.
E. nerifolia Linn.
E. pycnostegia Boiss.
Glochidion hohenackeri Bedd.
Macaranga peltata (Roxb.) Muell. Arg.
Mallotus philippinensis (Lamk.) Muell. Arg.
Phyllanthus simplex Retz.
Putranjiva roxburghii Wall.
Ricinus communis Linn.
Sapium insigne Benth. var. *malabaricum* (Wt.) Hook. f.
Securinega virosa (Roxb. ex. Willd.) Baill.
Tragea mulleriana Pax et. Hoffm. var. *unicolor* Pax and Hoffm.
Trewia polycarpa Benth.

Ulmaceae :
Celtis cinnamomea Lindl.
Trema orientalis (Linn.) Bl.

Urticaceae :
Boehmeria scabrelia (Roxb.) Gand.
Girardinia zeylanica Decne.

Moraceae :
Ficus arnottiana Mig.
F. asperrima Roxb.
F. racemosa Linn.
F. glomerata L.

Salicaceae :
Salix tetrasperma Roxb.

Burmanniaceae :
Burmannia pusilla (Wall. ex Miers) Thw.

Orchidaceae :
Aerides crispum Lindl.
A. maculosum Lindl.
Dendrobium aqueum Lindl.

D. herbaceum Lindl.
Habenaria gibsoni Hook. f.
Peristylis densus (Lindl.) Sant. et Kapad.

Zingiberaceae :
Curcuma pseudomontana Gr.

Hypoxidaceae :
Curculigo orchioides Gaertn.

Agavaceae :
Agave sp.

Dioscoreaceae :
Dioscorea pentaphylla Voigt.

Liliaceae :
Chlorophytum glaucum Dalz.

Commelinaceae :
Commelina hasskarlii C. B. Cl.
C. maculata Edgees.
C. suffruticosa Bl.
Cyanotis concanensis C. B. Cl.
C. fasciculata (Heyne ex Roth) Schulte.
Murdannia spirata (Linn.) Bruckn.

Arecaceae :
Phoenix Sp.

Typhaceae :
Typha angustata Bory and Chaub.

Eriocaulaceae :
Eriocaulon dianae Fyson
E. minutum Hook. f.
E. rithoieanum Ruhl.
E. sieboldianum Sieb. et Zucc. ex Steud.
E. stellatulum Koern.

Cyperaceae :
Carex filicina Nees var. *glaucina* (Moeck.) Kuek.
Cyperus adulatus Kern.
C. cyperoides (Linn.) O. Kuntze var. *sub-compositees* (Cl.) Kuek.
C. difformis Linn.
C. distans Grah.
C. flavidus Retz
C. iria Linn.
C. malabaricus (Cl.) Cooke.
C. pangoreii Roxb.
C. pumilus Linn.
C. triceps (Rottb.) Endl.
Fimbristylis woodrowii Cl.
Fuirena glomerata Lamk.

Poaceae :
Apluda mutica Linn.
Arthraxon inermis Hook. f.
A. lanefoliatum (Trin. Hochst.)
A. meeboldii Stapf.
A. nudus (Steud.) Hochst.
A. quartinianus (A. Rich.) Nash.

Arundinella metzii Hochst. ex Miq.
A. pumila (Hochst.) Steud.
Capillipedium luegelii (Hock.) Stapf.
Coix lachyma-jobi Linn.
Cynodon dactylon Pers.
Dichanthium armatum (Hock. f.) Blatt. et. MCC.
Digitaria stricta Rath et R. and S.
Dimeria ornithopoda Trin.
D. stapfiana C. E. Hubb. ex Pilger
Echinochloa colonum (Linn.) Link.
E. frumentacea Link.
Eleusine indica (Linn.) Gaertn.
Eragrostis japonica (Thunb.) Trm.
E. unioloides (Retz.) Nees ex Steud.
Eulalia fimbriata (Hack.) O. Ktge.
Garnotia stricta Brongn.
Heteropogon contortus (Linn.) P. Beauv.
H. triticeus (R. Br.) Stapf. ex Craib.
Indochloa oligantha (Hochst.) Bor.
Isachne elegans Dalz.
I. globosa (Thunb.) O. Ktze.
I. gracilis C. E. Hubb.
Ischaemum indicum (Houtt.) Merr.
Jansenella griffithiana (C. Muell.) Bor.
Manisuris forficulata C. E. C. Fischer.
Oplismenus compositus (Linn.) Beauv.
Paspalum compactum Roth. var. *fimbriatum* Bor.
Pogonachne recemosa Bor.
Pseudanthistria heteroclita (Roxb,) Hook. f.
Pseudodichanthium serrafalcoides (Cooke et. Stapf.)
Setaria glauca (Linn.) P. Beauv.
S. italica (Linn.) P. Beauv.
S. tomentosa (Roxb.) Kunth.
Spodiopogon rhizophorus (Steud.) Bor.
Themeda quadrivalvis (Linn.) O. Krze.
Tripogon capillatum Jaub. et. Speach.
T. lisboae Stapf.
Triplopogon ramosissinuum (Hack) Borm.
Gnetanceae (Gymnospermae) Gnetumula Brongn.

6.7 : Ornamental Plants and Vegetation of Dangi Hills :

Harishchandragad, Ratangad, Aundha-Patta fort, Kalasubai, Rajur all lie in 'Dangs' of Akola taluka. The flora and ornamental plants of these places were collected by V. D. Vartak (1971) and has published a paper on them in *Journ. Poona Univ., Sci. and Tech.* Section No. **40**, 1971, pp. 17—184. He had approached Harishchandragad from Akola and had collected 800 plants in the Dangi Hills covering wider area than covered by Billore and Hemadri (1969). Out of these, 70 species have been described as ornamental besides the common ones like *Ceiba malabarica.*

The habitant plants at Kalasubai, Ratangad, Harishchandragad, Rajur, Pend-Shet etc. are so different that the plant communities there differ widely. There are several small and large platforms on hill tops at different heights e.g. at Pachnai, Kedarnath temple, below the conical top of Kalasubai etc. Plenty of grass, herbs and few shrubs grow on them, but they contain some rare temperate elements like *Delphinium indicum, Clematis wightiana, Thallictrumn dalzellii* etc. The soil is very

shallow hardly a few inches and gets washed away by high rains and winds. Colourful flowers of *Swertia minor*, *Swertia decussata*, *Paracaryum malabaricum*, bulbous lily—*Scilla indica*, *Hitchemia caulina*, *Ceropegia tuberosa*, *Habenaria rariflora*, *H. heyneana*, *H. grandiflora*, *Curcuma pseudomontana* are quite common in rainy season.

The exposed areas along the hill slopes on upper flats have *Delphinium*, *Senecio dalzellii*, *S. grahami* make beautiful carpets. Climbers like *Porona malabarica*, *Merremia umbellata* form small tufts of creeping plants.

But really good flora of Kalasubai and other Dangi hills is in axillary coupes between two parallel hill slopes called Zure and in the valleys. Tropical evergreen small-leaved species mostly grow here. Only a few tree species like *Careya arborea*, *Terminalia crenulata* occur. They form isolated pockets or patches of semi-evergreen or evergreen plants, but nowhere outside Zure on exposed slopes. They are the counterparts of *Sholas* in Nilgiris. Should there be some protected flat ground, bowers of *Lagerstroemia parviflora* and *Olea dioeca* are formed, In the valleys *Trewia polycarpa*, *Wrightia tinctoria*, *Careya arboresa*, *Litsea zeylanica*, *Pongamia glabra*, *Mangifera indica*, *Actinodaphne angustifolia* form semi-evergreen forest. On the sunny slopes of valleys *Eranthemum rosens*, *Adelocaryum coelastrum*, *Centratherum*, *Phyllolacenum* or *Coix lachrymajobi*, *Plumbago zeylanica*, *Moghania strobilifera* grow crowded. Root parasite *Christisonia lawii* grows on underground parts of bushes. The undergrowth consists of two ferns *Pteris quadriaurita* and *Tectaria macrodenta*, and a small grass. The valleys and ravines being deep, there is good moisture in the weather always. The trunks of trees and branches are fully covered by mosses and epiphytic orchids. The mosses are yet to be studied. Epiphytic orchids are *Aerides crispum*, *Aerides maculosum* and *Dendrobium falcata*. Creepers of *Tylophora dalzellii* spread on trees.

In open, cleared areas in forest *Lobelia nicotiaenifolia*, *Gloriosa superba*, *Asparagus racemossus* grow. They merge with drier areas having *Woodfordia fruticosa*, *Clerodendron serratum*, *Thespesia lampas*, and *Glochedion hohenackeri*, *Olea dioeca* and bamboos. They form thickets and bowers on small open areas at mid-altitude flats. *Porana racemosa*, *Argyreia strigosa* grow at higher level. A number of grasses grow all over where there is little soil on sunny side, but not much on the other side at Konkankada of Harishchandragad. It has a steep drop of rocks several hundred metres down; there is no soil and rocks dry up as soon as the showers stop.

However, where the rocks are moist due to continuous water trickling from the top, *Begonia crenata*, *Impatiens pusila*, *Ammania floribunda*, *Adiantum philippensis*, *Burmannia* sp., grow in tufts in crevices and ledges of rocks due to water seeping through them. They last till the water is available. But very remarkable is the occurrence of *Terniola zeylanica* and *Dierea dichotoma*, both belonging to family Pedostemaceae, abundant in South Indian Ghats and in Ceylon. It seems that they have reached the northerly limit of distribution here. They are found on rocks in evergreen or semi-evergreen forest streams.

At places where soil gets accumulated in large quantities, and is not washed down, *Pimpinella tomentosa*, *Begonia crenata*, or *B. striatula* grow with grasses and small Cyperi. In deep forest shades *Lastrea zeylanica*, *Hamiltonia suaveolens*, *Habenaria grandiflora* are found.

In moist and temporary water logged places *Exacum bicolor, Exacum petiolair, Stemodea viscosa, Sopubia delphinfolia, Ramphicarpa longifoliata, Dysophylla stellata* grow mixed with grasses and sedges.

The vegetation of Dangi hills thus is unique in many respects. It has relict species of moist deciduous or evergreen vegetation such as *Trewia polycarpa, Careya arborea* which are broad-leaved, and *Ligustrum neilgherrense, Olea dioeca* which are small-leaved; but both grow in isolated pockets in valleys and ravines. Temperate elements like *Impatiens scapigera, Delphenium* grow on high top plateaux above 3000′ and monsoon ephemeral flora grows above 2000′. *Senecios* grow at the same altitude and are tropical as well as temperate species. Mixed semi-evergreen vegetation slowly leads to dry deciduous vegetation towards Rajur. There are some relict species. The vegetation in valleys contains evergreen or semi-evergreen species. Other outer areas have dry scrub or grassy plains. They are really the counterparts of *Sholas* of Nilgiris. They are responsible for Hooker and Thomson (1855) considering Mawals as a separate sub-unit of flora. They are worthy of intensive investigation from various points of view besides those studied by Billore and Hemadri (1969) and Vartak (1971).

Wild Ornamental Plants From Harishchandragad, Ratangad and Dangi Hills (after Vartak, 1971)

Ranunculaceae :
Clematis wightiana Wall.
Thalictrum dalzellii Hook.
Delphinium dasycaulon Frees.

Polygalaceae :
Polygala persicariaefolia DC.
Malvaceae :
Abutilon polyandrum W. and A.
Thespesia lampas Dalz. and Gibs.

Malphigiaceae :
Aspidopteris cordata A. Zuss.

Balsaminaceae :
Impatiens scapigera Hook.

Rutaceae :
Murraya paniculata Jacq.

Papilionaceae :
Crotalaria retusa Linn.
Indigofera pulchella Roxb.
Smithia purpurea Hook.
S. setulosa Dalz.
Cylista scariosa Dalz.
Moghania strobilifera St. Hill.

Crassulaceae :
Kalanchoe olivacea Dalz.

Melastomaceae :
Sonerila scapigera Hook.

Lythraceae :
Ammania floribunda CL.
Woodfordia fruticosa Kurz.
Lagerstroemia parviflora Roxb.

Lacythidaceae :
Careya arborea Roxb.

Begoniaceae :
Begonia crenata Dryand.

Umbelliferae :
Pimpinella tomentosa Dalz.
Peucedanum grande Clarke.
Heracleum pinda Dalz.

Rubiaceae :
Anotis lancifolia Hook.
Pavetta indica Linn.
Hamiltonia suaveolens Roxb.

Compositae :
Conyza stricta Willd.
Centratherum phyllolaenum Benth.
Cyathocline purpurea Kuntz.
Cyathocline lutea Law.
Notonia grandiflora DC.
Senecio grahami Hook.
S. dalzellii Clarke.
Lobelia nicotianaefolia Heyne.

Plumbaginaceae :
Plumbago zeylanica Linn.

Oleaceae :
Ligustrum neilgherrens Clarke.

Apocynaceae :
Holarrhena antidysenterica Wall.
Wrightia tinctoria R. Br.

Asclepiadaceae :
Ceropegia bulbosa Roxb.

Gentiniaceae :
Exacum bicolor Roxb.
E. lawii Clarke.
E. petiollare Griseb.
Swertia decussata Nimmo.

Boraginaceae :
Paracaryum malabaricum Clarke.
Adelocaryum coelestinum Brandis.

Convolvulaceae :
Porana malabarica Clarke.
Merremia umbellata Hall.

Scrophulariaceae :
Stemodia viscosa Roxb.
Sopubia delphinifolia G. Don.
Rhamphicarpa longiflora Benth.

Orobanchaceae:
Christisonia lawii Wight :

Lentibulariaceae :
Utricularia reticulata Smith :

Acanthaceae :
Eranthemum roseum R. Br.
Thelepaepale ixiocephale Brem.
Carvia callosa Brem.

Barleria lawii T. Anders.
Asystasia dalzelliana Santapau.
Ecbolium linneanum Kurz var. *dentata* Clarke
Justicia betonica Linn.

Verbenaceae :
Callicarpa tomentosa Murray.
Clerodendron serratum Spreng.

Labiatae :
Pogostemon plectranthoides Desf.
Dysophylla stellata Benth.
Colebrookea oppositifolia Smith.
Leucas montana Spreng.

Polygonaceae :
Polygonum glabrum Willd.

Elaeagnaceae :
Elaeagnus conferta Roxb.

Orchidaceae :
Dendrobium barbatulum Lindl.
Aerides crispum Lindle.
A. maculosum Lindl.
Habenaria rariflora Rich.
H. heyneana Lindl.

Zingiberaceae :
Hitchenia caulina Baker.
Curcuma pseudomontana Graham.

Liliaceae :
Gloriosa superpa Linn.
Chlorophytum glaucum Dalz.
Asparagus racemosus Willd.

Araceae :
Remusatia vivipara Sch.

Eriocaulaceae :
Eriocaulon indicum Moldenke.

Cyperaceae :
Cyperus exaltatus Retz. var. *divers.*

Filicineae :
Adiantum philippens Linn.
Aleuritopteris farinosa Fee.
Pteris quadriaurita Retz.
Lastrea eriocarpa Docne.
Tectaria macrodonta C. Chr.

Besides these, there are also some common handsome flowering trees such as *Bombax ceiba, Butea monosperma, Erythrina stricta, Pongamia glabra, Cassia fistula* etc. which are commonly known.

7. FLORA OF SHOLAPUR DISTRICT :

Arid climate of Sholapur, rich black cotton soils, low irregular rainfall, Ramling Hill and its flora.

7·1 : *Climate, Soil and Rainfall*

The district is hemmed between Satara, Sangli, Pune, Ahmednagar, Osmanabad, and Gulbarga (Karnatak State). Sholapur district is rather dry but has very rich, fertile black cotton soil. The average annual rainfall is 23.00". There is a great variation in annual rainfall from year to year and place to place. The temperatures are high, average maximum being 39.90C. The district lies in the famine zone with Bijapur, Ahmednagar and eastern parts of Pune district. The vagaries of rainfall and high temperature do not allow continuous growth of plants.

Once in three years the crop is abundant, because of the fertile, deep black cotton soil. There is a tendency for the salt to effervesce, making the soil at the surface unsuitable for plant growth. The whole district is plain. There are no hills worth the name, except Ramling, which is a small hill about 25.6 km north-east of Barshi, situated on a spur of Balaghat range of Sahyadris. The plants of this place were collected and described by Prof. S. D. Bhagwat and are given below

There is a Forest Nursery at Ramling which has introduced many ornamental trees like Gulmohor, *Peltophorum*, *Casuarina* on the hill here. There is Ramling temple, much sacred to the Lingayat community. Many trees are planted around the temple also. There are a few seasonal streams which dry up but two streams on the hill, Ramling *odha* and Nagzari do not dry up even when several others dry up after December.

7·2 : *Flora of Ramling Hills :*

This is a typical of Sholapur area which is so dry. Ramling is a small hill 25.6 km N.-E. of Barshi. It is situated on the Balaghat range of Sahyadris. Its altitude is 2177 feet above the M.S.L. The hills are barren at the top. Ramling hill is covered by some important commercial and medicinal plants, such as *Gardenia lucida*, *Anogeisus latifolia*, *Terminalia arjuna*. More important species occur in the shallow valleys, some occur on the plains. They represent the flora of plains in the district. The vegetation of Ramling is of dry deciduous type bordering on scrub. In monsoons it is green. The rainfall is about 30". A striking ephemeral flora appears during monsoons. The ephemerals flower suddenly. They are short-lived, as the plants bear flowers, fruits and seeds quickly, and disperse them. After the seed dispersal all of them die. There is no vegetation except parched grass and ephemerals. For the rest of the year hills and plains look desolate. Many ephemerals belong to Compositae and tuberous Liaceae, but the hill top is barren. There are *Acacia catechu*, *Zizyphus xylocarpa*, *Gymnosporia montana*, *Carissa congesta*, *Fluggea leucopyrus and Sirrus pallida* and some Shrubs and climbers like *Daemia extensa*, *Marsdenia* (*Dragea*) *volubilis*, *Rivea hypocrateriformis* and *Cocculus hirsutus*.

Some trees grow on slopes and along Ramling stream going into valley. They are *Boswellia serrata*, *Acacia catechu*, *Sizygium cumini*, *Cassia fistula*, *Zizyphus xylocarpa*, *Z. oenoplia*, *Salamalia malabarica*, *Carissa congesta*. Some herbs like *Cleome simplicifolia*, *Anisochillus carnosus* are common. On slopes *Sarcostemma acidum*, *Caralluma fimbriata*, *Exacum pumilum*, *Smithia conferta* occur. Two ferns *Actinopteris dichotoma and Adiantum capillus veneris* grow in the ledges of rocks. The new plants introduced in the area are *Jacaranda ovalifolia*, *Tamarindus indica*, *Ficus tsiela*, *Cissus tomentosa*, *Grewia tilaefolia*, *Gloriosa superba*, *Gardenia lucida* etc.

The plants seen along the railway track are mostly herbaceous such as *Bidens pilosa, Acanthospermum hispidum, Xanthium stumarum, Rhyncosia* sp. Other herbaceous plants are *Indigofera linifolia, Euphorbia hirta, Polygala chinensis, P. minima, Phyllanthus lawii, Echinops echinatus, Alysicarpus* sp., *Boerhaavia diffusa, Portulaca oleracea, Indigofera cordifolia, Lepidagathis mitis.* The small trees noticeable are *Cordia dichotoma, Glossocordia lineifolia, Pterocarpus marsupium.* Besides these plants *Anacardium occidentale, Delonix regia, Jacaranda mimosifolia* are cultivated.

It will be seen that the list contains a large number of dry deciduous species as those on dry hills of Ahmednagar. The full list of plants has been given by Bhagwat (1968) in "The study of Ramling plants" in *Shivaji Univ. Journ.* 4. 50-57, 1968. This is quoted below. The flora consists of 238 species belonging to 60 families of flowering plants, and only two xeric ferns, *Actinopteris dichotoma* and *Adiantum cappilus, Avenezia.* The vegetation is typically dry deciduous or scrub. The herbaceous vegetation whether on slopes or hill top is ephemeral.

Only a few thorny scruby plants survive the heat of summer and a few geophilous Liliaceous tubers which appear again in August.

Flora of Ramling Hill Areas :

Menispermaceae :
Tinospora cordifolia (Willd.) Miers.
Cocculus hirsutus Diels.

Cruciferae :
Brassica nigra Koch.

Capparidaceae :
Cleome simplicifolia (Camb.) Hook. and F. and Th.
Cleome viscosa L.

Moringaceae :
Moringa oleifera Lamk.

Polygalaceae :
Polygala persicarifolia DC.
Polygala chinensis L.
Polygala erioptera DC.

Caryophyllaceae :
Polycarpea corymbosa Lamk.

Portus acaceae :
Portulaca oleracea L.
Portulaca tetrafida L.

Malvaceae :
Abutilon indicum Sweet.
Hibiscus rosa sinensis L.
Thespesia populnea Soland.
Sida veronicifolia Lamk.
Sida acuta Burm.

Bombacaceae :
Salamalia malabarica (DC.) Sch. and Endl.

Tiliaceae :
Grewia tiliaefolia Vahl.
Grewia pilosa Lamk.
Triumfetta bartramia Linn.
Corchorus olitorius L.

Malpighiaceae :
Aspidopteris cordata A. J

Zygophyllaceae :
Tribulus terrestris L.

Oxalidaceae :
Biophytum sensitivum (Linn.) DC.

Rutaceae :
Eagle marmelos L.

Burseraceae :
Boswellia serrata Roxb.

Meliaceae :
Azadirachta indica A. Juss.
Melia compositae Willd.

Celastraceae :
Gymnosporia montana Benth.
Elaeodendron glaucum Pers. Syn. V.

Rhamnaceae :
Zizyphus mauritiana Lamk.
Z. xylocarpa Willd.
Z. cenoplia Mill.

Ampelidiaceae :
Cissus pallida Planch.
Cissus tomentosa Vahl.
Cissus elongata Wall.

Sapindaceae :
Cardiospermum halicacabum L.

Anacardiaceae :
Mangifera indica L.
Anacardium occidentale L.

Papilionaceae :
Heylandia latebrosa DC.
Indigofera linifolia Retz.
I. cordifolia Heyne.
I. glandulosa Willd.
I. trita L. F.
Tephrosia purpurea Pers.
Zornia diphylla Pers.
Alysicgarpus tetragonolobus Edgew.
A. ru aosus DC.
A. pubescens Law.
Erythrina indica Lamk.
Butea monosperma Kuntz.
Atylosia scarabaeoides Benth.
Rhynchosia minima DC.
Dalbergia sissoo Roxb.
Dalbergia latifolia Roxb.
Crotalaria orizensis Willd.
Crotalaria filipes Benth.
Abrus precatorius L.
Psoralea corylifolia L.
Pterocarpus marsupium Roxb.
Desmodium latifolium DC.
Desmodium diffusum DC.
Phaseolus aconitifolium Jacq.

Phaseolus trilobus Ait.
Crotalaria chinensis L.

Caesalpinnae :
Caesalpinia pulcherima Swartz.
Caesalpinia sepiaria Roxb.
Delonix regia Raf.
Parkinsonia aculeata L.
Cassia auriculata L.
Cassia fistula L.
Cassia absus L.
Cassia sophora L.
Cassia tora L.
Cassia siamia Lamk.
Bauhinia racemosa Lamk.
Bauhinia tomentosa L.
Tamarindus indica L.
Hardwickia binata Roxb.
Peltophorum inerme Naves.

Mimosae :
Prosopis specigera L.
Mimosa hamata Willd.
Acacia arabica Willd.
Acacia leucophloea Willd.
Acacia catechu var. *Cundra* Prain.
Pithecolobium dulce Benth.
Samanea saman Merr.

Combretaceae :
Terminalia arjuna W. and A.
Anogeissus latifolia Wall.

Myrtaceae :
Syzygium cumini (Linn.) Skeels.
Eucalyptus hybrida.

Lythraceae :
Ammannia baccifera L.
Lagerstroemia parviflora Roxb.

Ficoidae :
Mollugo pentaphylla L.
Trianthema monogyna L.

Umbelliferae :
Hydrocotyle asiatica L.

Rubiaceae :
Oldenlandia corymbosa L.
Oldenlandia aspera DC.
Gardenia lucida Roxb.
Borreria stricta K. Sch.
Morinda citrifolia L.
Plectronia wightii Cooke.
Anotis foetida Bth and HK.

Compositae :
Tridax procumbens L.
Eclipta alba Hask.
Cyathocline purpurea (Don.) C. Kuntz.
Caesulia axillaris Roxb.
Xanthium strumarum L.
Gnaphalium indicum L.

Ageratum conyzoides L.
Glossocordia linearifolia Cass.
Lagasca mollis Cav.
Acaenthospermum hispidum DC.
Vernonia cinerea Linn.
Echinops echinatus Roxb.
Sonchus oleraceus L.
Tricholepis amplexicaulis Clarke.
Certhamum tinctorius L.

Plumbaginaccae :
Plumbago zeylanica L.

Oleaceae :
Nyctanthes arbor-tristis L.

Apocynaceae :
Carissa congesta DC.
Plumeria acutifolia Woodson.
Vinca pusilla Murr.
Anodendron paniculatum A. DC.

Asclepiadaceae :
Hemidesmus indicus R. Br.
Daemia extensa R. Br.
Sarcostemma acidum Veight.
Marsdenia volubilis T. Cooke.
Caralluma fimbriata Wall.
Calotropis gigantia R. Br.
Gymnema sylvestre R. Br.

Gentianaceae :
Exacum pumilum Griesb.
Canscora diffusa R. Br.
Enicostemma littorale Bl.

Boraginaceae :
Heliotropium indicum L.
Heliotropium supinum L.
Trichodesma indica R. Br.
Cordia dichotoma Forst.

Convolvulaceae :
Rivea hypocrateriformis Choisy.
Evolvulus alsinoides
Convolvulus arvenis L.

Solanaceae :
Solanum nigrum L.
Solanum xanthocarpum Schard.
Physalis minima L.

Scrophulariaceae :
Verbascum coromandelianum Kuntze.
Herpestris moniera Dalx. and Gibbs.
Striga densiflora Benth.
Striga euphresioides Benth.
Striga gesneroides Vatke.
Sopubia delphinifolia G. Don.
Lantana camara L.

Bignoniaceae :
Dolichondrone falcata Seem.
Jacaranda ovalifolia R. Br.

[*O. J. mimosifolia*]
Millingtonia hortensis L.

Martyniaceae :
Martynia diandra Glox.
Sesamum indicum L.

Acanthaceae :
Justicia simplex Don.
Lepidagathis cuspidatus Nees.
Lepidagathis mitis Dalx.
Asteracantha longifolia Nees.
Strobilanthes sp.
Rungia elegans Dalz.
Barleria cristata.

Verbenaceae :
Vitex negundo L.
Tectona grandis L.
Lippia nodiflora L.
Clerodendron phomidis L.
Lantana camara L.

Labitae :
Orthospiphon pallidus Royle
Anisochillus carnasus Wall.
Ocimum sanctum L.
Leucas biflora R. Br.
Leucas longifolia Benth.

Nyctaginaceae :
Boerhaavia diffusa L.

Amaranthaceae :
Celosia argentea L.
Achyranthes aspera L.
Amaranthus spinosus L.
Amaranthus blitum L.
Amaranthus paniculatus L.
Pupalia astropurpurea Moq.
Digera arvensis Forsk.
Alternanthera sessilis R. Br.
Aerua lanata Juss.
Aerua javanica Juss.

Santalaceae :
Santalum album L.

Euphorbiaceae :
Euphorbia neriifolia L.
Euphorbia hirta L.
Euphorbia thymifolia L.
Pedilanthus tithymelodides Poit.
Euphorbia elegans Spreng.
Euphorbia geniculata orteg.
Euphorbia hypericifolia L.
Phyllanthus niruri L.
Phyllanthus lawii Grah.
Phyllanthus maderaspatensis L.
Jatropha curcas L.
Ricinuscommunis L.
Acalypha malabarica Muell.
Acalypha ciliata Forsk.

Moraceae :
Ficus religiosa L.
Ficus bengalensis L.
Ficus glomerata Roxb.
Ficus tsiela Roxb.

Casuarinaceae :
Casuarina equisetifolia Forst.

Hypoxidaceae :
Curculigo orchioides Gaertn.

Agavaceae :
Agave Sp.

Liliaceae :
Gloriosa superba L.
Iphegenia indica A. Gray
Iphegenia pallida Baker
Scilla indica Baker
Urginea indica Kunth
Chorophytum tuberosum (Roxb.) Baker
Aloe vera L.

Commelinaceae :
Cynotis tuberosa Schult.
Cynotis fasciculata Schult,
Commelina nudiflora L.
Commelina benghalensis L.

Eriocaulaceae :
Eriocaulon sp.

Typhaceae :
Typha angustifolia Bory.

Cyperaceae :
Cyperus corymbosus Rottb.
Fimbristylis monostachys
Fuirena wallichiana Kunth

Graminae :
Andropogon pumilus Roxb.
Aristida funiculata Trin & Rupr.
Arthraxon sp.
Coix lachryma-jobi L.
Cymbopogon martini Stapf.
Chrysopogon montanus Trin.
Dactyloctenium aegiptiacum Willd.
Eulalia argentea Brogn.
Eragrostis sp.
Heteropogon sp.
Melanocenchris jacquemontii Jaub.
Polytoca barbata Stapf.
Setaria sp.

Polypodiaceae :
Actiniopteris dichotoma Bedd.
Adiantum sp.

8. CONCLUDING REMARKS ON THE FLORA OF DESH DISTRICTS

Considered as a whole the vegetation of Desh districts has developed under semi-arid conditions. It is dry deciduous mostly except in the regions adjacent to Sahyadri ranges where the rainfall is high and has

resulted in the creation of discontinuous pockets of semi-evergreen or moist deciduous forests. They are not rich and continuous but rather irregular.

A special feature of the flora of northern part of Sahyadris is the Dev Raies. Their vegetation is different from that of the surrounding areas. They have conserved the ancient types like *Gnetum ula*, *Entada pursaetha*, *Haligerna grahami*, *Conarius wightii* (Mahabale 1979).

They represent climax vegetation of the past ages, and are not the climatic climax of the present time. The vegetation of Kolhapur, Satara and Pune districts is varied and rich; that in Junnar area, Purandar and Harishchandragad has preserved some endemic species which deserve to be fully studied for their physiology and autoecology.

The rich vegetation of Malabar botanical province in South Konkan slowly changes to dry or semi-arid vegetation as one goes North. Sahyadri ghats have preserved many rare plants of different taxa and are a veritable treasure of different plants, their ecotypes and possibly mutants.

CHAPTER IX—GENERAL CONSIDERATIONS

CONTENTS

CHAPTER IX—GENERAL CONSIDERATIONS

This Section deals with general considerations regarding the plants of Maharashtra, their classification, flora, floristic analysis, vegetation, certain special plant groups, history of Botany and Palaeobotany in Western India, and early botanists who have contributed to our knowledge of Botany and plants of this State.

Some noteworthy floras such as the flora of hill tops, *ghat* flora, monsoon ephemerals, aquatic plants have been described. The distribution of principal families and plants has been given in relation to those in the adjoining States. Striking families Podostemaceae, Orchidaceae, Balanophoraceae, Scrophulariaceae have been considered.

A large number of open grasslands occur throughout the State. Their fodder grasses have been enlisted. Similarity between grasses of Assam and grasses of the Sahyadri region is pointed out. Different elements in the flora of Maharashtra, Tropical, Subtropical, Temperate and relict species have been considered.

Another important section of this chapter deals with the plants of special habitats, such as, drought resisting plants, water plants, xerophytes and succulent plants, parasites etc. Exotic and endemic plants, wild tuberous and other edible plants, medicinal plants, honey yielding plants, plants in Dev Raies are given. Importance of these various plants lies in their relation to the present day plants in plant breeding and plant introduction, weed control, ethno-botany and pollution control. Some wild beautiful plants worth introducing in botanical gardens and parks have been noted.

In Botany these days, there are some newer disciplines, such as, Chemotaxonomy, Numerical taxonomy, Aerobiology, Palynology, Bee Botany, Ethnobotany etc. They are briefly considered. Crop plants and crop pattern, fruit trees, their wild parents, their original home have been given. Some botanically interesting plants are likely to become extinct. Need for their conservation and preservation of endemics is emphasized.

The present day flora is the result of various changes in geological, climatic and historical factors. Fossil floras and Archaeological plants help in understanding them. The fossil floras in the State are briefly described, mainly Mesozoic in the Wardha-Vainganga-Godavari Valley and Tertiary flora found in the Deccan Intertrappean Series around Nagpur. Quaternary plants found on calcareous shales in Pravara at Sangamner, those in Travertine tufa on Mula river bank, at Kotul in Ahmednagar district have been described specially.

Several river valley projects are going on in the State. The construction of dams on them at different places in this and adjacent States on Koyna, Narmada, Tapi, Pench, Vainganga, Kukadi, Krishna, Bhima and others are bound to make changes in aspects of our vegetation. Some parts of it may even vanish, these need close study. Attention is drawn to them also.

The titles of different topics dealt with in this chapter indicate the range of subjects covered under General considerations, *viz.*, (1) Taxonomic, (2) Floristic, (3) Economic, and (4) Historical. In short, they deal with the major problems concerning the plants of this State.

A. SOME TAXONOMICAL CONSIDERATIONS —GENERAL

Throughout the present work we have considered plants in a synoptic way, and not with a view to give their detailed descriptive taxonomy, as that would need reference to localities and to herbarium sheets in Indian herbaria and in the herbarium of the Western circle of Botanical Survey of India, Pune, and also to plants in other herbaria.

The *Flora Indica* of J.D. Hooker was completed by about 1897. It is largely based on the Bentham and Hooker's system of classification of plants. It is used throughout the erstwhile British colonies and is still being followed. The whole collection of plants at Kew consisting of several millions of specimen and types of Indian plants at Kew, are also arranged according to the Bentham and Hooker's system of classification. It is still the authentic and authoritative official system followed in the Indian National Herbarium at Calcutta. It is very necessary therefore, that we should know it in a little more detail, its merits and defects and shortcomings. It is considered here synoptically as in the Introductory Essay to the *Flora of British India* by Hooker and Thompson (1855), but not as in Cooke's (1901-1908) *Flora of the Bombay Presidency*, wherein all the known localities and herbarium material are cited and many important places from which plants were collected are referred to in the text of that work.

Towards the middle of last century Charles Darwin published his well-known book, "*The Origin of Species*" in 1859. It created a sensation in the world of science. The natural outcome of it was, the people came to believe in Evolution, and that changed their outlook towards science then in existence. The same thing happened in Botany also. Till that time the sytems of classification that were in vogue were based on the idea of constancy of species. Darwin clearly showed that it was not true. The species are variable and mutable and that the present day species have been derived from their ancestors existing in the distant past, with a change. At that time Palaeobotany was coming up as a separate discipline due to the efforts of French Botanists Brongniart (1770-1847) and the British botanist Williamson (1870). The result was that it became quite evident that many groups of plants differing from the present ones have had disappeared in long course of history, so that our attempts to prove or show that all the present day plants have been constant and are derived from exactly similar past plants had to be given up. But there was a lot of opposition to it. At that time influencial French taxonomist A.P.De-Candolle (1824-1873) had formulated a very elaborate system of classification of plants *Prodromus systematis regni vegetabilis*, since the days of Linnaeus. It runs into 17 large volumes wherein all the then known plants were classified and described. The various categories of plants formulated by Linnaeus and other taxonomists like Tournefort were then commonly used in France and Europe. They accepted species, order or Family, Class and Series as units of classification. But De-Candolle was a believer in the constancy of species as groups. Therefore, he was not in favour of arranging a system of classification of plants according to the idea of changeability of species which was the result of Darwin's work. However towards the end of his work he accepted the idea and changed his approach in his next work, though not in earlier volumes of "Prodromus".

Bentham was not a botanist by profession but an engineer. He had great interest in plants. Botany at that time was a compulsory discipline for medical students and so many well-known medical men were good

botanists e.g. Dr. Williamson, Dr. Gibson etc. Bentham had made huge collections which he parted to the Kew gardens and classified them as a member of the staff of the Royal Botanical Gardens at Kew.

Kew gardens at Richmond near London originally were the property of the King of England, Richard the Third. By the middle of 18th century, it got completely disfigured and deteriorated to a very great extent. As a result, the King parted with it and created a Trust for looking after it. Sir William Hooker (1785-1865), a British botanist, trained at Edinburgh and in-charge of the Botanical Gardens, Edinburgh, was appointed its first Director in 1841. Bentham, well versed in, taxonomy was appointed to be a member of the staff of the Royal Botanical Gardens at Kew. There came into existence by about 1869 a joint system of classification of plants named after Bentham and Hooker which is still used in English speaking countries.

The main features of Bentham and Hooker's system are : They divide the system into two divisions of seed plants Dicotyledons and Gymnosperms together, and Monocotyledons. They classified them into the then known genera of plants, about 97205, into various categories. They split the Dicotyledons into 6 Series, Monocotyledons into 8 Series and Gymnosperms into 4 Series. This was a new way of arranging. But it is to be remembered that every system of classification largely utilises the information and knowledge gained from the previous ones and tries to improve upon it. So did Bentham and Hooker's. Their full system as it is followed is given below separately. It should be noted, however, that this system has some defects in it, and also some novel points. The novelty is that it created new groups called Disciflorae and Monochlamideae. In the earlier classifications of Linnaeus or Tournefort there were also heterogenous groups. But Bentham and Hooker had put under Monochlamideae or Apetaleae all those families of plants which could not be classified properly into other groups. This is highly artificial and quite defective, because sometimes most unrelated plants or families are put together e. g. in Bixineae. Another interesting feature, which was wrong, is that Bentham and Hooker classified gymnosperms along with dicot flowering plants together as Spermatiphyta. They considered that the hermaphrodite flowers as those of Magnoliaceae or in fossil *Williamsonia*, to be more primitive, and unisexual flowers to be higher. Families such as Euphorbiaceae, Salicaceae were considered to be advanced. This was largely to suit the idea of Williamson that hermaphrodite flower of *Williamsonia* may be primitive. This was not accepted by authors of the phylogenetic system like Engler and Prantl. To them Amentifereae or plants bearing unisexual flowers in catkins were primitive than those with bisexual flowers of *Magnolia* or *Williamsonia*. Engler's system is arranged on this basis (1892). This is not the place to discuss the merits or demerits of the various systems, but only to point out the limitations and special features of them each. In Bentham and Hooker's system, gymnosperms are put together with angiosperms, as they both are seed-bearing plants and have two or more cotyledons, therefore, they are put together. This, of course, was never accepted by later taxonomists and they made Gymnosperms a separate Class or Division colateral with Angiosperms. But the easy way in which the Bentham and Hooker's system can be handled, irrespective of its phylogenetic implications, is the main reason why it is followed by many even today. It should be noted, however, that on the continent of Europe including Russia, Engler's phylogenetic system of classification is more popular and is widely followed.

We have been adopting Bentham and Hooker's system for two reasons: (1) Our type material* at the Indian National Herbarium, at Calcutta and that at Kew is based on Bentham and Hooker's system, (2) Classification followed in the authoritative flora of India, *Flora Indica* published by J. D. Hooker, son of the great British botanist Sir William Hooker (1785—1865) has followed it for describing 17,000 species of India. This number has now certainly become still larger and till the authoritative floras of India as a whole, adopt, any other system of classification, it is wise to use the same system. After all the taxonomy is the playground of botanist and taxonomists and change of names needs enormous previous literature at hand, which is rarely the case. Very often it only creates confusion in the minds of workers who have no access to all the early literature. Therefore the names as given in Bentham and Hooker's system in *Flora Indica* and in the *Flora of Bombay Presidency* by Theodore Cooke (1901-1908) or in the *Flora of Khandala* by Santapau (1967, 3rd Edition) are largely followed, supplemented by other accepted names here and there in *The Flora of Hassan District* by Rev. Father Dr. Cecil J. Saldanha (1976), or *Index Kewensis.* At present latest new system of classification of flowering plants is that of Cronquist, Zimmermann and Takhtajan (1966), but that is not adopted in the present work.

Distribution of taxa in Bentham and Hooker's '*Genera Plantarum* is given below as in Bentham and Hooker's system of classification of Spermatophyta or Seed-bearing plants (1862-1893):

DICOTYLEDONS

I. Polypetalae—Plants with free petals.

- Series 1. Thalamiflorae. Hypogyneae. 33 Orders from Rannculaceae to Tiliaceae.
- Series 2. Disciflorae—Receptacle or a disc present. 25 Orders from Geraniaceae to Moringaceae.
- Series 3. Calyciflorae. Flowers generally perigynous, sometimes epigynous. 27 Orders from Rosaceae to Cornaceae.

II. Gamopetalae—Corolla with fused petals.

- Series 1. Inferae—ovary inferior. 9 Orders from Rubiaceae to Companulaceae.
- Series 2. Heteromerae—ovary superior, carpels more than 2. 12 Orders from Ericaceae to Styraceae.
- Series 3. Bicarpellatae. Ovary often superior with two carpels. 24 Orders from Oleaceae to Labiatae.

III. Monochlamideae—Perianth simple.

- Series 1. Curvembryeae—Embryo curved. 31 Orders from, Nyctaginaceae to Polygonaceae.
- Series 2. Multiovulatae Aquaticae—submerged herbs single Order Podostemaceae.

*Type material is a herbarium specimen on which original description or diagnosis of a species or Taxon is based as defined by Section 2 of the *Rules of Botanical Nomenclature* (1972).

Series 3. Multiovulate Terrestres—Plants Terrestrial. 3 Orders from Nepenthaceae to Aristolochiaceae

Series 4. Micrombryeae—Plants with very small embryo 4 Orders from Piperaceae to Monimiaceae.

Series 5. Daphnales—Ovary with a single ovule. 4 Orders from Laurineae to Elacagnaceae.

Series 6. Achlamadosporeae—Pistil 1—celled, ovules 1-3. 3 Orders from Loranthaceae to Balanophoreae.

Series 7. Unisexuals. Flowers unisexual. 9 Orders from Euphorbiaceae to Cupuliferae.

Series 8. Ordines anomali or Anomalous families. Relationship, uncertain, 4 Orders from Salicacea to Ceratophylleae.

GYMNOSPERMAE

4 Orders. Gnetaceae, Coniferae, Cycadaceae and Ginkgoaceae.

Lawrence (1951) estimated 97,206 species of seed-bearing plants, others estimated 2 lakhs.

Before Linnaeus the species as units of plants taxonomy were recognised, but their denotations was not fixed. They used to apply them to various groups small or large. It was Darwin (1859) who gave proper meaning to the term 'species' and their evolution by variation, in his well known book "*The Origin of Species*". To each species Linnaeus gave two names, one generic and one specific. Before Linnaeus and Darwin the concept of species was there, but the method of nomenclature was not rigidly followed. There used to be one name for the Genus and another name for the species, the first one they called 'generic' and the other 'trivial' respectively. Sometimes there used to be three names or even four names for the same plants. This afterwards created confusion. To avoid this Linnaeus devised the rule of Binomial nomenclature which necessarily requires two names for a plant and a third name for the variety. The rule *per genus et differentia*, is now strictly followed except for the cultivated plants where they mention either the variety or the cultivated garden races or strains as cultivars. However, all biologists are not agreed as to the exact content of the different catagories of nomenclature such as genus, species, sub-species, cohort etc. The last term was introduced by De Candolle. There is a broad agreement as regards the term "Genus" which is considered by some to be a better unit in classification, and for the purposes of plants breeding rather than species. But opinions differ on this point, though it is largely agreed that genus is a larger and continuously evolving unit genetically. The 'Family' as a unit was brought into use later. Previously it used to be called 'Order', but now they call it 'Family'. This term has completely replaced the term 'Order'. Thus our present knowledge of taxonomic terms, their import have been brought into use, and a common understanding is stabilised, largely by the efforts of several botanists based on the ideas mentioned above. The term 'Taxon' is a generalised term for a unit or any category in Taxonomy. It is now preferred.

Leursen and others use an additional criterion for a 'Species' namely, the geographical distribution. Due to geographical isolation many

species tend to become endemic and get separated from an evolving complex of an original species, thus terms eco-types, bio-types, cytotaxonomic types, comparium have come into use, widening the use and meaning of a large species complex. The process of isolation of a species from its centre of origin is due to geographical barriers such as high mountains, oceans, deserts etc. Therefore, geographical distribution also is an important consideration for a species. Species which have poor means of migration get completely isolated from each other. The species of Bryophytes, mosses, algae are classified taking into consideration their geographical distribution. It should however, be remembered, that after all no classification can ever be complete or ideal phylogenetically, as our knowledge of the various reproductive mechanisms and life processes of plants continuosly goes on improving. New ideas are introduced and the classification gets modified. That is how the present concept of Biosystematics has come into existence. Our aim in taxonomy is to know plants as they have evolved in nature at a time, recognise them, and know their relationship with others which means Phylogeny, a term introduced by Earnest Hackel in 1860. But this is an ideal not easy to reach and is not likely to be reached. Therefore, whether we use, Bentham and Hooker's system or Phylogenetic system of Engler and Prantl or modified Bentham and Hooker's system of Hutchinson is immaterial from the view point of practical applicability. However, the final test of relationship between species and species, groups and groups lies in their ability to produce fertile progeny by crossing. We do know at present that there are interspecific and rarely intergenetic crosses. But this is by way of exception. The normal rule is that the individual within a species complex — the genus — is or should be fertile. This still holds good and attempts to change genes experimentally is a long process. To alter thousands of genes of a species effectively in order to give requisite combination of characters will also be a still longer process of Bioengineering.

In "*Genera Plantarum*" of Bentham and Hooker the families, genera then known have been described. The tendency to split the families lumped together into different families, or to split different genera lumped together, to transfer species from one family to another, because our knowledge of their relationship is now better, has increased the number of species or Families put together before. Therefore it looks as if some new families have been discovered, but that is not necessarily the case.

Like Linnaeus or Lindleyan system of classification of plants, Bentham and Hooker system is based on gross morphological characters rather than on any artificial criteria such as the numbers of stamens of some vegetative characters. Its nomenclature also is relatively easy. It is based on the well-known work "*Genera plantarum*" of Bentham and Hooker (1862 to 1883).

Stated briefly, Bentham and Hooker's system of classification of Spermatophyta comprises 163 of Dicot families, 34 of Monocot families, together with 197 families of Flowering plants, and 4 Families of Gymnosperms or Gymnospermia which have 415 living species spread over 44 genera. It is considered a collateral group with Angiosperm.

Bentham and Hooker's system or classification of seed-bearing plants or Spermatophyta has been largely used in England, India and other English speaking countries like Australia, New Zealand or Singapore, because to change thousands of herbarium specimens in a large herbarium

is impracticable. Secondly, it is a very easy system to follow, as it is based on similarities of external morphological characters, although it is not strictly phylogenetic. On the continent of Europe, the phylogenetic system of Engler and Prantl is mostly followed.

In the *Flora of the Bombay Presidency*, Cooke (1901—1908) has recorded 127 families. Since then no new families have been discovered nor any family has been eliminated by the separation of Gujarat, Sind, Karnatak from the previous Bombay Presidency. The flora of Maharashtra now comprises flora of Marathwada and Vidarbha in addition to the flora of remaining old Western Maharashtra. Despite this, the total number of families has remained nearly the same, now estimated to be 144. At present botanists have estimated 144 families, 838 genera, 1939 species with 132 varieties in the Maharashtra region.

1. Interesting Families of Angiosperms in Maharashtra

In this part we shall deal with some general botanical problems connected with the plants in Maharashtra. The most striking feature in the topography of Maharashtra is the spread of Sahyadri ranges and their hill tops. The ascent of species from plains to hill top is not easy as compared to their descent from the crests to plains below. There is also a considerable disturbance to vegetation and even destruction by the local people, going on for centuries.

Second important feature noticeable here, on the Desh side, is the uniformity of dry deciduous forests, and some unique plant families in Sahyadris. There are about 417 families of angiosperms in the world and nearly 2 million species. J. D. Hooker has enumerated approximately 17,000 species of plants in India. They belong to about 127 families. Most of them are quite common to various regions. The largest family in India is the Orchidaceae having 1,500 species, but it is not so well represented in Maharashtra flora. The largest genera having maximum number of species in Maharashtra belong to Gramineae or Grasses. They occupy large areas. Next is Leguminoceae and third is Compositae followed by Rubiaceae and Acanthaceae. Orchidaceae stands fourth. Orchidaceae is a very interesting family biologically, due to its habit, mode of nutrition and method of pollination. Many orchids are epiphytic and some are terrestrial. Among the terrestrial genera. *Habenaria* is the largest genus having over 25 species in Maharashtra, Some are terrestrial and some are epiphytic. Among the epiphytic orchids *Dendrobium* is the largest genus of orchids in India, as well as in Maharashtra. *Eria* is another large genus of orchids in India, but is having only a few species—4 in Maharashtra. However, there are other large families like Verbenaceae, Rubiaceae, Combretaceae which are very important economically. The well-known timber tree *Tectona grandis* belongs to Verbenaceae and *Adina cordifolia* belongs to Rubiaceae. Both are extremely important species from the view point of economy. Combretaceae is mostly woody. The strange thing about Rubiaceae and Verbenaceae is that they have equal number of tall woody and small herbaceous members. Some are extremely small and herbaceous. This is rather anomalous, as it does not easily fit in the system of classification of Hutchinson into Lignosae and Herbaceae. That only shows that a family may be having woody and herbaceous members at the same time. There are however, only few families which show this peculiarity. Another family which has woody trees, shrubs and herbaceous members is the Leguminoceae. The genus *Cassia* is a standing example. It has large woody trees like *Cassia siamea* or *C.*

fistula, shrubs like *C. auriculata* and also extremely small herbaceous species *C. pumila*. There is difficulty about the shrubs. The alternating periods of hot and cold climate possibly have reduced them to their present status as shrubs.

There are a few families in Maharashtra which have extremely small distribution or unique distribution. The smallest family of flowering plants both in size and differentiation of parts is the Lemnaceae. It has only two-three common genera *Lemna* represented by three species, *L. minor*, *L. polyrhiza* and *L. trisulca*. The other genus *Wolffia* as well as *Spirodela* are monotypic. They have no roots and look like some small green alga. This family, in spite of its small size, is very extensively distributed in fresh waters in Maharashtra in tanks, reservoirs and rivers. It is carried to different places by floods or by legs of birds. It thrives also in brackish waters. This probably explains its spread far and wide. The only limitation on its distribution is put by its own ability to survive. If the ponds in which it grows get dried up, it dies; but survives somewhere else. The story of its biology is exactly the same as that of the small water fern *Azolla pinnata*. The third important family worthy of note is the Podostemonaceae. This family has discontinuous distribution, and its members are found on rocks in high torrential streams. In Maharashtra it is found in the streams of the Western ghats at high altitude and is represented by 5 genera. In Peninsular India it is represented by the genus *Podostemon* after which the family has been named. But this genus is rarely found in Maharashtra. The other genera *Griffithella*, *Hydrobryum* and *Dicraea* are found in the streams at high altitude along the ghats in Sahyadris. Willis (1902) has based his 'Age and Area', hypothesis on the basis of the discontinuous distribution of the members of this family, *inter alia* its distribution in Peninsular India, at Shillong, Sri Lanka etc. The discontinuity in its distribution is very great and this family deserves special attention from the biological point of view. I is described in brief in subsequent pages.

The other important parts in this chapter deal with the fossil plants of Maharashtra. The most important thing to be noted in this connection is the fact that the geographical position of the Sahyadris has not changed along its longitudinal axis, and as such it still contains some important members in its flora which have continued right from the Tertiary period till today. Most of the present day Maharashtra flora is of Tertiary origin, largely of Miocene and post Pliocene and a few of Eocene origin. However, some plants have survived from the end of Cretaceous to present era and have stood all the vissicitudes of climate. The earlier floras of Maharashtra were along the banks of the Narmada, Krishna and Godavari rivers. They had many gymnosperms in the Gondwana period, but they have not survived, except perhaps only *Gnetum ula*.

Another peculiarity of the flora in Maharashtra is the general absence of gymnosperms. Those which are seen today are all cultivated. The only gymnosperm found wild in the flora of Maharashtra is *Gnetum ula*. This is, however not found in the deciduous forests all over Maharashtra, but only in the semi-evergreen forests and Dev Raies along the Konkan coast and on high top valleys. Strangely enough, it is found at Mahabaleshwar (Fitzgerald Ghat), in coastal strand forests of Jawhar, at Lonavala, Khandala, Amboli in hill top forests; but it is not found on the hill top of Matheran. This is not

easily explicable. It is also not found in forests elsewhere. Other three interesting families of Maharashtra are the Orchidaceae, Podostemaceae and Balanophoreceae. These families (in the flora of Maharashtra) are of special interest. Of these the Orchidaceae is large and Podostemacae and Balanophoraceaė are small. They are briefly treated here.

(*a*) *Orchidaceae* :

This family has pretty flowers and floral mechanisms for cross pollination and different mode of mutation. It comprises 15,000 species in the world, spread over 480 genera. It is cosmopolitan in distribution, but is largely concentrated in Malaya, India, Sri Lanka and Africa. According to Hooker there are 1,600 species of orchids in India, and is the largest family in the Indian flora. The species are abundant in Himalayas, Assam and Western Ghats. They are both terrestrial and epiphytic, approximately equal in number. They produce adventitious roots from rhizome or pseudobulb. The leaves are generally leathery. Some have reedy stem three feet high. The epiphytic species cling by their roots to tree trunks on which they grow from very minute, light seeds carried away by wind in thick jungles. Roots are provided with special water storage tissue-exodermis. Some orchids are quite small e. g. *Eria dalzellii.* They form button like pseudobulbs. In Nilgiris there is one orchid which is hardly an inch in diameter. It has no leaves and has flat radiating greenish roots, arising from the little stem, which gives rise to a small floral stock bearing minute flowers *Taeniophyllum* (*T. zoolinyeri* ?). Roots of some orchids are symbiotic or photo-synthetic. Some orchids store mucilage and others store food material in their root tubers e. g. *Orchis palmata*, or in pseudobulbs in epiphytic *Erias*, and of epiphytic orchid *Rattenjyota* growing in the neighbourhood of Girisappa Falls in Mysore. These bulbs are full of mucilage and are sold in Bombay market. They are used medicinally e. g. *Orchis palmata* roots (*Punjab Salam*) used as a tonic.

Flowers of *Dendrobium*, *calantha*, *Arides maculosum* and other species, *Rhychostylis* are very handsome and look like garland. Many species can be hybridized. A hybrid orchid called *Brassocattaelia* is derived from three different genera *Brassawola*, *Cattleya* and *Laetra* by crossing.

Fruit of orchids is an inferior capsule called diplotegia Pods e. g. *Vanila* pods are famous for fragrance they give to ice-cream. They are extracted for obtaining essence of the same name used in ice-cream, pastries and cosmetics. It is an epiphytic orchid which climbs 30 feet on trees with the help of its clinging roots.

Orchids have one or two stamens. There are thus two kinds of them, monandrous and diandrous. Their pollination is effected with the help of insects touching a peculiar structure called gynostemium. They are attracted by the odour of flowers, some having foul smell e. g. *Acampe ochreata*; and some have good odour. There is a cultivated orchid called *Peristeria elata* or Dova Orchid, which produces extremely fragrant flowers. It is a terrestrial orchid with large pseudobulbs or tubers. A floral stalk comes out of large, 5-6 leaves, and bears 8—10 fragrant, white flowers in succession. Their aroma fills the room and lasts nearly 15 days.

Cooke (1901—1908) in the *Flora of the Bombay Presidency* has described 74 orchids, but recentl :antapau and Kapadia (1966) in their

paper " Orchids of Bombay" (Govt. Publication, Calcutta), have revised and described the orchids of Bombay as comprising 123 species belonging to 42 genera. Konkan, Western Ghats, Mahabaleshwar are the favourite places of orchids. They are prohibited for collecting or cutting by the Forest Department. There they grow terrestrially as well as epiphytically, they perennate by tubers, bulbs or pseudostem. Malaya is the biggest exporter of orchids, especially Singapore, where there is a special Orchid Park. The people there propagate them by callus culture.

A special section of terrestrial orchids consists of the saprophytic orchids. Many terrestrial orchids harbour fungi. Remarkable among them are parasite on parasite orchids like *Neottia*, *Epigonum* etc. The fungus grows on grass roots and on these grasses orchids grow parasitically. These orchids thus show double parasitism, a super-parasitism. Orchid family represents the highest level of evolution among monocots and has become the symbol of imperialism. Winston Churchill, the imperialist, always used to wear an orchid flower in his button hole.

Orchids are often cultivated out of fancy in hot houses. They need shade, shelter and diffused light. There is National Orchidarium at Darjeeling. There is also one at Shambagnur near Kodaikanal in Catholic seminary. For enumeration see list of orchids compiled by Santapau and Kapadia (1966). A natural Orchidarium exists at Biligirirangan, Ercaud, Castle Rock and Mahabaleshwar in thick woods.

(*b*) *Podostemaceae* :

This is a unique family of flowering plants as its plants have thalloid structure looking like *Anthoceros*. They have no roots or distinct stem or leaves. The thalli grow only in substrate rocks in fast moving streams or torrents. They are highly adapted to aquatic conditions and to arid conditions when torrents stop flowing. By about December-January receding waters of streams cease to flow and the plants are dried up as white patches on rocks, where water flowed before, looking like lichens or dried fleshy liverworts. They are confined to high altitude, 3,000 and above.

Plants have minute leafy, out-growths with small seeds. Small peduncles appear on thalli, bearing minute trimorphic or zygomorphic flowers with four anthers. As they mature they form dehiscent fruits. Seeds get dispersed with water and are left in the debris on the banks of streams. In Maharashtra they are found at Mahabaleshwar, Pratapgad, Harishchandragad, Tryambak, Karla, Bhaja near Lonavala, Rohideshwar etc. It is common in high hills in the South and in Sri Lanka, Assam, Meghalaya.

The family is well-known for its short span of life. There are 45 genera and 200 species of it in the world. 6 genera and 6 species of it occur in Maharashtra. They have been described by Vartak and Bhadbhade (1973) with illustrations. Embryology of the family has been worked out by Razi (1949, 1966). The species show discontinuous distribution being located only at place with high altitude and heavy rainfall. They form the basis of Willis' 'Age and Area hypothesis'. Wider the distribution greater the age and plants with small localised distribution turn endemic. They are considered to be more ancient.

Later Willis modified his views and propounded the theory of progressive and regressive endemism. An endemic species may begin to spread again or may tend to have more and more localized distribution. Both the processes are at work in nature and this point is discussed by Mahabale (1966, pp. 102—107). There is vast literature on Endemism, only selected literature on the family is given at the end of this topic.

Willis (1902) has sub-divided this family into the Podostemaceae and Tristichaceae.

Distribution of Podostemaceae in Maharashtra

Genus and species (1)	Locality (2)	Flowering period (3)	Remarks (4)
1. *Terniola zeylanica* (Garda) Tul.	Tryambak, Igatpuri, Mt. Kalasubai, Harishchandragad, Bhimashankar, Matheran, Lonavala, Bhaja, Karla, Rohideshwar, Amboli ghat, Tinai ghat Dudsagar, North Kanara.	Sept-Dec.	Also occurs in Ceylon on smoot-gnesis rocks in streams at Peradenya in Karnatak State.
2. *Terniola zeylanica* var. Konkanensis (Willis) Sant	Khandala, streams in the Island of Salsette. Konkan, Deccan, Igatpuri and Kasara on the Thal ghat. Sakharpathar hill, Lonavala, Khandshi river near Borkas, Warandha Ghat.	Sept-Dec.	
3. *Terniola zeylanica* var. malabarica Willis.	Dudhsagar ..	Sept-Dec.	Karnatak State.
4. *Dicraea stylosa* Wight	Harishchandragad .. Bhimashankar, Lonavala, Mahabaleshwar.	Oct-Jan.	Madagascar, Sri Lanka, Tropical Africa.
5. *Zeylanidium lichenoides* Engler.	Junnar, Lonavala, ..	Sept-Oct.	..
	Mahabaleshwar.		

(1)	(2)	(3)	(4)
This species has 2 varieties.			
var. 1 *Khandalensis Willis.*	Common at Khandala.	..	...
var. 2 *bhorensis Willis.*	Found in Bhor-ghat near Khandala.	...	...
6. *Hydrobryopsis sessile* Engler.	Dudhsagar.	Dec-Febru.	Karnatak State.
7. *Griffithella hookeriana* Warm.	Harishchandragad, Junnar, Pratapgad, Konkan, Atgaon.	...	Also in Kala-Nadi (North Kanara), Karnatak State.
8. *Podostemon subulatus* Gardn.	Harishchandragad.	Aug.-Oct.	Sr Lanka, on rocks in the Mahaweli Ganga river.

Genus *Podostemon* occurs widely in Sri Lanka and in Assam (Meghalaya). It is not known from peninsular India. Except from a few places.

(*c*) *Balanophoraceae* :

The third peculiar family in Maharashtra is Balanophoraceae. It is a root parasite, growing on the roots of *Carvia callosa, Carissa congesta.* It was reported by Birdwood and Woodrow possibly occurring on *Murraya paniculata* Jaq. It was first located at Mahabaleshwar wood below the Dhobi's Fall by Mrs. W. E. Hart as early as 1885 and described by her in Volume 1: 75 of the *Bombay Natural History Society's Journal.* Later it was collected by Vartak on *Carvia callosa* at Ligmala Fall at Mahabaleshwar and at Khandala by Santapau (1941-1949), but it could be located again at Khandala. Blatter has described it elaborately in *Bombay Natural History Society's Journal* in 1929, Vol. 33-309 under the name *Balanophora Indica* Wall. as a new species.

The species is dioecious. It produces about 6-9" white stalks or peduncles with globular heads of male and female flowers. The ovules lie in long drawn out sheaths and look like Corpocephalia. There are no leaves, except during reproductive phase, otherwise it cannot be seen or recognized. It is equally common in woods below cascades at Kodaikanal and other places in South India.

Recently Vartak and Chitnis (1977, p. 155) have reported another species, *Balanophora dioeca* at Hivre in Dr. Alexander Gibson's Park and Botanical Garden, in Junnar taluka, in Pune district.

Besides *Balanophora Indica* the following plants also are root parasites. Their relationship with the host needs further study.

(*d*) *Orobanchaceae* :

1. *Orobancheae gyptica Pers.*—This is a pernicious pest on the roots of tobacco and jowar. It appears generally in winter.

2. *Orobanche ceruna Loeft.*—It is rather rare. The former is a scapagerous herb with pendant floral stalk, flowers purple coloured and seeds minute.

3. *Aeginetia indica Linn.*—It is a parasite on *Strobilanthus* and on *Carvia callosa*. It occurs at Rohideshwar and Panshet. It has tuberous rhizome and short coral-like roots.

4. *Christisonia Lawii* Wight and (5) *Christiansonia calcarata*—Both parasitise on *Strobilanthes* at Khandala, Lonavala, Thane, etc.

5. *Cistanche tubulosea* Wight.—It is a pretty looking parasite on roots and underground parts of *Salvadora persica* Ahmedabad. It has not been reported from any part of Maharashtra.

(*e*) *Scrophulariaceae* :

1. *Striga sps.*—There are six species of this parasite on grasses. They generally grow in pastures in rainy season. They are plenty in grasslands around Pune, Kolhapur, particularly 5 species *Striga lutea* and *S. alba* and *Striga orobancheoides*. It is quite common in grasslands in hilly parts at Khandala, Mahabaleshwar etc. Recently Dr. S. B. Kamble of B.S.I., Pune has found *Alectra parasitica* on the roots of *Vitex nigundo* in Akola District in Vidarbha.

2. Tentative Analysis of Maharashtra Flora

The flora of British India written by Hooker now nearly hundred years back has estimated about 17,000 species of flowering plants belonging to 176 families. This estimate undoubtedly needs to be modified considerably after the revision undertaken by the Botanical Survey of India for the plants in the country. However it indicates broad outline of plant world in the sub-continent. Flora of the reconstituted Maharashtra also needs to be revised as many new species are added to it. The broad trends indicated by the analysis by Blatter (1908) of the flora of the erstwhile Bombay Presidency still holds, good as no new family is added by the addition of the new area to it.

The Botanical Survey of India was started by Dr. King in 1890 and he also initiated writing regionwise floras. The first regional flora of any State in India was the "*Flora of the Bombay Presidency*" by Dr. Theodore Cooke between 1901 and 1908.

In the "*Flora of the Bombay Presidency*" Cooke has described 2,530 species. The flowering plants in it belong to only 117 Orders. Of these 22 Orders on families have not more than 2 species, and 12 have only one specie.

The present position, however, is slightly different because of the researches of various taxonomists like Blatter, Mc Cann, Santapau, Vartak, Puri, etc. Members of the Botanical Survey of India have added

many more species to those described by Cooke. At present they are estimated as follows : The genera 838+4 new and species 1939+496 newly added. Cooke had enumerated only 117 families, but due to modern trend of splitting them into smaller families this number is estimated to be 133. The most important families in Maharashtra, in point of number of species and genera, are as follows :—

Serial No.	Family	Species	Genera
(1)	(2)	(3)	(4)
1	Poaceae (Gramineae)	281	56
2	Papilionace	187	49
3	Cyperaceae	107	11
4	Acanthaceae	106	31
5	Asteraceae (Compositae)	102	47
6	Orchidaceae	94	24
7	Euphorbiaceae	89	30
8	Rubiaceae	68	29
9	Asclepiadaceae	59	24
10	Scrophulariaceae	59	24
11	Lamiaceae (Labiateae)	54	21

The total number of genera recorded by Cooke were 838. Later additions to Cooke's Flora made by others have increased the total number to 1,003 genera and 2,509 species. The new additions are 6 genera, and 848 species. There has not been addition to the number of families. Some of the families have very wide distribution, whereas others have comparatively very limited distribution.

These families may be compared with the dominant families with other parts in the country surrounding Maharashtra, namely, Karnatak, Malabar, Andhra Pradesh, Madhya Pradesh and Gujarat. The dominant families in Maharashtra are Graminae and Leguminoseae. They have the largest number of species and genera. They grow again during monsoons, and last till January. This is mainly because the whole of rainfall is only for a period of 4 months. Because of this the dominant families in different regions are different in ranking. This becomes evident from the Table on next page.

TABLE No. IX—A-2-1—SHOWING THE ORDER OF DOMINANCE OF 10 ANGIOSPERM FAMILIES

Family	Flora of Khandala (Poona district) as per Santapau (1957)	Flora of Junnar and surroundings (Poona district)	Thana District Flora	Flora of Phonda-Amboli ghats (Ratnagiri district)	Flora of Goa	Cooke's Flora of the Presidency of Bombay	Gamble's Flora of Presidency of Madras	Hooker's Flora of British India	Flora of Agumbe (Shimoga district, Mysore State)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Poaceae	I	I	I	IV	II	II	II	III	III
Fabaceae	II	II	II	I	I	I	I	II	I
Asteraceae	III	III	III	V	VII	IV	VII	VII	VI
Cyperaceae	V	IV	IV	VIII	IV	VI	VIII	VIII	V
Euphorbiaceae	VI	V	V	II	III	V	V	V	VII
Acanthaceae	IV	VI	VI	III	VI	III	IV	VI	IV
Rubiaceae }	IX	VIII	VII	VII	V	VII	III	IV	II
Convolvulaceae }	X	IX		XI	VII	X	..	..	XII
Orchidaceae	..	..	VIII	..	..	..	..	I	..
Scrophulariaceae	VIII	X	IX	..	XIII	..	..	..	..
Lamiaceae	XII	VII	X	VI	X	..	IX	IX	XI

3. Distribution of Angiosperm Families in Maharashtra

The distribution of plants is primarily governed by climate, secondarily by soil conditions and is further delimited by the biotic Influence of plants and animals mutually. Among the climate the factors pertaining to rainfall, range of temperature and humidity, drought period and its ratio to the humid period are important. The varied topography of India having different soils makes difference in the distribution of species as they also are important factors in the spread of plants. In the spread of species it is not the intrinsic number of the seeds formed by a species, but the germination of their seeds and survival of the seedlings; their ability to stand in varied climate and soils, and their adaptability to micro-climate that determines the rate of survival of seedlings. For example a large number of seeds are formed and fall at the edge of Sahyadris (plants like *Memecylon umbellatum*). Despite their enormous number of seeds, the number of plants that survive ultimately at different places in the ghats is very small. This is largely due to the fact that seeds get washed away from the edge down to the valleys and lower slopes. There they do germinate but are unable to face drought period and get dried up completely and often die in summer. It is only in those places where the debris of dried leaves and organic material and water are available for them to germinate, that the seedlings survive. Many species which do not stand high temperature or low temperature or frost gradually migrate from their original place to other more favourable places. The soils in India are derived from different types of rocks and their nature changes according to their origin. In Chandrapur and Bhandara districts, soils are sandy. Elsewhere they are of Deccan trap origin. They do not mature under identical conditions, nor are they formed at the same altitude or time. This makes them different in their rate of maturing. A characteristic type of soils of Deccan traps in Maharashtra is Black cotton or Regur soil. The problem of Regur soil has been already discussed elsewhere and need not be repeated here. These soils generally contain clay fraction in large amount. They do not have enough organic matter. They do not retain water and develop cracks due to their sticky nature. Water in them gets evaporated from the cracks formed, exposing thereby the underground parts of the plants. The second type of soils, are sandy or loamy. The latter are fertile but they do not contain all the ingredients necessary for the plant growth like black cotton soils. Their fibral nature, loose particles, allow the water to percolate quickly down from surface. The rain water spreads to roots and the growth of plants is better. The best growth of the trees especially is to be seen in the loamy or mixed soils of Chandrapur. In Bhandara and parts of Nagpur the soils are mixed. They are also good for plant growth. We shall therefore consider the distribution of some important families only.

The distribution of plants is said to be continuous, discontinuous, cosmopolitan, rare or endemic. All these kinds are to be found in the distribution of families and individual members among the plants of Maharashtra. But as a rule, no endemic family is found. This is mainly because the Maharashtra flora contains many plants from the surrounding areas and they grow mixed. There would hardly be a few species which are rare in the whole of flora. Not more than 200 species have been mentioned by Cooke as rare in Bombay Flora, but about two dozen only are endemic. The number of endemic species indicates the past history of the family, but what were considered to be rare, come to light sometimes from entirely different areas, and thus their rare character is lost. Such examples are not infrequent. Cooke's findings therefore

have to be taken with modification. The first ten families numerically superior to others are also common to South Gujarat and Madhya Pradesh, and Telangana in Andhra Pradesh, part of Northern Karnatak being contiguous. They indicate the relationship of the Maharashtra flora to that of the adjoining regions. However certain families have greater representation in Maharashtra than in other areas e.g.Gramineae. Some like Podostemonaceae are unique. The largest family in India is Orchidaceae but in Maharashtra Gramineae is number one. The absence of a family also indicates only rarity ; some indicate past history. For example the family Dipterocarpaceae. This family had large distribution in the past in Peninsular India, but now it is very restricted in distribution not only in Maharashtra but in the whole of Peninsular India. As a matter of fact, *Dipterocarpus, Shorea, Anchistrocladus, Litsea* are not found in the flora of Maharashtra, but they do occur in the flora of Madhya Pradesh and Karnatak. Madhya Pradesh has the largest number of Leguminosae in the country, but it is second in Maharashtra.

As examples of endemics *Frerea indica, Iphigenia stellata, Senecio hewrensis, Seshagiria sahyadrica, Arisaema caudatum, Kalanchae bhidei, Dicanthium mccannii, Euphorbia erythrodata,* some grasses, *Ceropegia* and *Habenaria* species may be cited as endemic.

The order of predominant families here is Gramineae and Leguminosae. They have different places in the surrounding States. Although this suggests that Maharashtra is rich in grasses, and that fodder for cattle should be abundant, but it is not really so because the edible grasses completely dry up soon after December. There is a great preponderance of perennials in Maharashtra nearly double the annuals and biennials. This accounts for the deficiency of grass partly. The number of trees constitute nearly double the number of herbaceous plants, but they also dry up in summer.

The proportion of monocots to dicots is 1:3·2 as against 1·2:2·7 in the whole of India. Monocots constitute 26 families as against 115 families of Dicotyladons. The larger genera undoubtedly are from the family Graminae such as *Andropogon, Panicum,* and in the dicotyladons *Crotalaria* and *Indigofera.* The ground orchid genus *Habinaria* is very large. The other larger genera are *Hibiscus, Vitis, Ipomoea, Euphorbia, Ficus , Grewia, Impatiens, Acacia* and *Leucas.*

Just as there are large families, there are also others which are very small or scarce. Among these there are some which are tending to wards endemism. Blatter (1908) has found 127 endemic species in Bombay Presidency of which 55 belong to monocot and 72 to dicotlydons. However, with further knowledge of the distribution of the different species and families, this number is bound to be changed.

Nearly 1/7th of the species are climbing. They belong to the families Leguminoseae, Convoloulaceae, Asclepiadaceae, Cucucibitaceae, Vitaceae, Menispermaceae, Apocyanaceae, Celastraceae, Oleacaeae. 1/3rd of these are woody. The giant among them is a woody species found in Dev Raies, *Entada pursaetha* which has the largest dicot seeds in practically the whole of plant kingdom and has also huge pods. It is a liana which climbs on tree tops in evergreen and semi-evergreen forests in Konkan, Khandala and in the Ghat region. There are 40 parasitic plants, the important of which are *Aginetia indica* growing in the midst of clumps of *Euphorbia refifolia, Chrastisonia lawii, C. calcarata* growing on the roots of Karvi, *Carvia callas.*

Recently Dr. S. B. Kamble has reported a new root parasite on the roots of *Vitex negundo* in Akola district, *Alectra thomsonii* and *Alectra indica (parasitica)* (family Scrophularaceae). They grow on the roots of *Vitex nigunda*. *Cistanche tubulosa* of the same family grows on the roots of *Salvadora persica*. Various species of *Orobanche*, one of which is a parasite on the roots of tobacco and jowar, and is a bad weed, also *Striga orobanchioides*. *Balanophora indica* growing on the roots of Karvi (*Carvia Callosa*) is found at Mahabaleshwar, and *B. dioceae* at Hiwre (Dist. Pune). These are complete parasites. They are not green like *Cuscuta sps*. or semi-parasite like *Cassytha*, species of *Loranthacea* such as *Scurrula*, *Taxillus*, etc. There are not many epiphytes in Maharashtra except in high rainfall region adjoining Sahyadris such as *Remusatia vivipara*, *orchids* like *Dendrobium*, *Acampe*, *Aerides*, *Eria* species. A few ferns *Leucoustegia pulcra*, *Pleopeltis membranacea*, *Niphobolus* sps. are seen in semi-evergreen forests and in Deo Raies.

Many monocots belonging to Zingibera Ceae, Liliaceae, Musaceae, Asclepiadaccae form underground tubers—with the help of which they perennate. These plants are important in maintaining the soil cover on the high crest flats of Sahyadris and on the mountain tops. There are a number of Saprophytic plants especially some orchids. Without association with fungus ground orchids are unable to grow in soil. As regards the insecticide plants, there are only a few. The genus *Utricularia* is a well known aquatic plant having some marshy species also. They trap insects in utricles and digest them. There are three principal types of utricles. *Utricularia stellata* is a floating aquatic species which produces four floats in the midst of which the long scale comes out. They balance the plant on surface of water e. g. in Vihar Lake, Bombay. Other species produce root utricles e. g. *Utricularia striatula* growing at Panchgani, Khandala, etc. They produce traps on the leaves. All these species have to be fully investigated. The other insectivorous genus is *Drosera*. Two species of it are found in high rainfall region ; one in marshy places such as Khandala. They have large sticky tentacles on leaves by means of which they produce shining traps ; they mislead and capture insects. *Drosera burmanni* is a flat species with rosette of red leaves and *Drosera indica* grows erect. Both the species are occasionally found in Bababudan hills in Karanatak. *D. indica* occurs at Khandala.

On the whole, the flora of Maharashtra for the greater part is well represented by dry deciduous species in the forests. It represents climatic climax. It is difficult to imagine that any other type of vegetation could have subsisted under the conditions of plant life here. Since the beginning of Tertiary period the greater part of it soon after the Deccan traps were formed in Eocene they are a constant feature of its flora. The soils derived from them have been the same but are matured at different periods. The rainfall pattern has been nearly similar, but there have been a few fluctuations in the climate throughout the course of the Tertiary period. The topography has remained more or less unchanged. There has been very little length-wise movement of Sahyadri except turning slightly to the east in Khandesh and Dangs but even that has been more or less the same. Therefore the conditions of plant life here are fairly constant. Occasionally there have been some variations but not so significant as to completely overhaul the pattern of the plant life.

This appears to have been so even in the past since post-Neogene period. Although the Deccan traps were poured on different terrain the conditions of geomorphology have been nearly similar. There

must have been large areas occupied by deciduous forests, most of them dry, and in some pockets moist. It is well-known that this type of vegetation is dominated by *Tectona grandis*, *Adina cordifolia*, *Anogeissus latifolia* community of plants. Hence throughout Western Maharashtra, Marathwada, Wardha, Nagpur, Bhandara and Chandrapur area we get dry deciduous forests. However, there are a few isolated patches where we find semi-evergreen or evergreen forests as the principal type. The semi-evergreen forests are seen mostly on the Desh side, especially where the rainfall is more than 60″, near the edge of Sahyadris as in Mawals. These Mawals are peculiar to the Desh. They are formed by the lateral spurs of Sahyadris or their branches. They isolate the flora from one another. Rivers rising from the main Sahyadri ranges and flowing eastwards give rise to more or less uniform climate on account of which the same type of forests and flora prevail. Isolation from each other makes them contain some plants which are localised and even endemic. The situation on the Konkan side is a little different. There at the foot of the Sahyadris, there is Tarai-like region and pockets of rich forests dominated by tropical trees, somewhat like that of Tarai at the foot of Himalayas. These also like semi-evergreen forests on Desh side are isolated. They never form a continuous stretch of the vegetational belt. Beyond them away from the main range there are also small strips of deciduous forests and then mangrove forests preceded by strand plants towards sea coast. On the crest of Sahyadris there are pockets of evergreen patches of forests in the valleys, but they again are isolated from each other. They generally contain the tropical as well as a few temperate elements. The temperate elements are confined to the high mountain tops ; the tropical elements are spread in the high humidity areas. The rest of the area has only the dry deciduous forests.

The rains in most of the dry areas are about 380 mm—760 mm. There are a few places where the rainfall is 1000 mm—1270 mm per annum. After October there is drought for nearly 8 months during which the herbaceous flora dries up. During the rainy season there are many large areas where good pastures or open grasslands occur. Thus the vegetation succession appears to be :

Evergreen forests,

Semi-evergreen forests,

Deciduous forests (moist and dry),

Scrub,

Grasslands.

This is, in brief, the picture of the vegetation of Maharashtra. It has remained nearly the same since the late Eiocene period.

As regards the various elements in Maharashtra flora, it has been noticed that they are mostly the south subtropical. A few temperate elements are there but they are of a secondary succession. The list of surviving Eiocene period plants is small. The great majority of plants at present are of the post-Miocene period. The Miocene species were nearly the same as now. Therefore most of our flora is of the Miocene and post-Miocene period. The second important peak of the volcanic activity after Eiocene was during Tertiary period. Some climatic fluctuations were there in Pleistocene, Glacial periods, but they have not much affected the Maharashtra area. We have very few places where we get the Placocene plants. On the river banks in a few places like Sangamner we find a complete succession of the flora. This succession

has led mostly to the dry deciduous trees and grasslands. A large number of plants found in the Quaternary are a mixture of dry and a few temperate species. But the temperate genera such as *Podocarpus, Salix* have disappeared. They are succeeded by dry deciduous species. This is seen in succession right from the basal most part on the traps at places in Konkan and on the Desh side. There are a number of animal remains in the archaeological horizons on the banks of rivers in Maharashtra. These are largely herbivorous animals and only a few carnivorous. To support herbivorous animals like elephant, goat, bullock there must have been large pasture lands and bushes than today, under which they could take shelter. This is seen from the study of archaeological plants and animals.

Regarding the elements that constituted the Maharashtra flora, it was noted that in addition to some original ones, some have come from surrounding areas, except perhaps from the desert region of Rajasthan. But all other regions such as Indo-Ganga planes, Malabar, East Assam have contributed to the composition of the flora in Maharashtra. There are, however, quite a few endemic species in Maharashtra, mostly belonging to the families Gramineae, Asclepidaceae, Legimunaceae, Compositeae, Rubiaceae, Musaceae. The number of rare and endemic species can be counted from Cooke's account of the flora of Bombay, about 200 species. Of course, this will change as our knowledge of the distribution of the species will increase. All the same quite a substantial part of it will remain intact. On the other hand, new endemic grasses, species of *Ceropegia,Phoenix* have been brought to light by the efforts of the different workers such as Blatter and McCann and the members of the Botanical Survey of India in the Western Circle. This shows that there has been some original flora in Maharashtra to which the elements from the surrounding areas were added; but only a small proportion of the original flora has remained here. It has also been ascertained that the post-Miocene plants from Andhra Pradesh, where also the Deccan traps occur have migrated westwards and southwards and have been added to the flora of Maharashtra. Thus the flora of Maharashtra today is somewhat different and is a composite flora wherein plants of adjoining regions have found suitable environment for their growth. The dry deciduous forests and dominant elements in them have changed but the general type has remained the same. The dry deciduous forests have arisen from the moist deciduous forests and from the evergreen or semi-evergreen forests. Ultimately they have resulted in scrub due to nature of the soil derived from traps in several places, and the subsequent soil erosion.

Thus it appears that the flora in Maharashtra is only slightly altered in course of long time. At no time it had continuous evergreen forests but only as isolated entities. Though the flora has not altered much, the composition, density and size of dominant trees have altered. The lofty *Tectona grandis* forests of Chandrapur represent that. They have been replaced by small sized stunted *Tectona grandis* trees in the present deciduous forests of Desh.

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B. CONSIDERATIONS OF ECONOMICALLY IMPORTANT PLANTS

4. Cultivated Plants and Their Wild Parents

Many cultivated plants are grown all over the world, They are derived from some wild ancestors of them found in natural surroundings. Most of the crop plants are thus derived, for example, wheat grows wild in Palestine, bajari in Africa and in India, coconut in Malaysia, Polynasian islands and India. Citrus fruits have their parents in wild species growing in Assam and north-west Africa. Origin of maize, though highly controversial, is probably in South America, of *Cajanns* in Western Ghats. Several species of rose grow wild in Himalayas, but they are not so ornamental as the culitivated ones. The widely cultivated grape vine (*Vitis vinifera*) has its orign in wild species of *Vitis*. But during its long cultivation by man, many of the cultivated plants have changed their character, especially those which are useful to man. In cultivation, however, they have become less resistant and susceptible to many plant diseases. Their fruit qualities and seed qualities are improved considerably by the repeated cultivation and selection by man, but their resistance capacity is not improved to the same extent. Similarly man being primarily interested in seedless fruits, he prefers parthenogenetically produced fruits, and species that propagate vegitatively to preserve the same characters as he wants and are founde useful in the species. Repeated hybridisation is also responsible for improvement in the performance and certain qualities. It however leads to deterioration in its reproductive capacities. Vegetative reproduction also results in some plants almost forgetting the normal way of sexual reproduction

Thus, many cultivated vegetable species are propagated mainly vegetatively. Potato, the original home of which is in America's East Mountains, and sweet potato, are examples. In Maharashtra also there are some wild plants which are the parents of the cultivated plants. Many species of *Vitis* are found wide ranging from highly woody ones like *Vitis repanda* to those that are very small and fleshy like *Vitis trifolia.* There are also xerophytic species like *Vitis quandrangularis,* but not all these are useful in the breeding work. The main purpose of crossing the cultivated species with their wild parents is to see how far the disease resistivity and reproductive capacity of the species would be increased, and how far they give the different types-cultivars that could be separately cultivated later. It is only by hybridisation and selection that the better varieties have been produced for most of the crop plants, cereals, fruits and vegetables. The process, however, has not been much used in forestry. This has resulted in not finding better varieties or more useful tree strains suitable for different regions of India today. The following list gives the important cultivated plants, their original home and wild parents. The specific criterion for determining the relationship of the wild species of a genus with the cultivated species is their ability to intercross and breed and produce a number of fertile types. This has been shown to be so in the case of *Cajanus cajan* and species of *Tylosia* growing wild in the hilly regions of Maharashtra. A number of crosses have been obtained, but very often not all crosses are economically useful. In a similar way, it is shown that various varieties of wheat that are cultivated today, both summer and winter varieties contain resistant genes of *Aegiolops* (Chennaveeraiah, 1964). This list will clearly show a wide choice for hybridisation and for getting back the resistance from the original parents by genetic work. But not much use of it has been made on a large scale. There is a wild citrus fruit growing in the midst of semi-evergreen forest known as *Atata racemosa.* It produces wild lemons quite bitter in taste but containing lot of juice and having lot of resistivity. About the cucurbits quite a number of them have been evolved and the varieties have been really made constant or fixed by usual processes of genetic fixation. But in agricultural and horticultural practice, it is the maintenance of the same variety or the same species or even the race which is of utmost importance to get the same quality of the fruit, seed or other parts. But sometimes in cross breeding one gets a better variety also. For example, a cross has been effected between *Anona squamosa* and *Anona reticulata.* This cross is so successful and produces fruits which are sweeter than *Anona squamosa.* The seeds are small and few, and the pulp is more as in the case of *Anona reticulata.* It would be worth while crossing other species of *Anona* also, and see what kind of fruits one can obtain.

The real difficulty comes in when one finds hundreds of varieties, and yet have the same chromosome numbers suggesting, as if they have the same genetic constitution. Mango is an example of this. All the species of mango including the Malaysian or the African species possess the same number of chromosomes in all of them 13. Wild mangoes are a rarity. The sour fruits they produce are so small and contain such a large stone that they are not very useful for eating. A similar story is that of Areca or the betelnut. Its wild parents are supposed to have been in the hills of Malabar, but no definite conclusions can be drawn about this. Just as the wild mango which is found in the Western Ghats of Sahyadris, especially in North Kanara and Sindhudurg district, we cannot say that all the cultivated varieties of Areca or mango have been derived from them. A repository and nursery of wild plants of the State is highly desirable.

All the cultivated crops, fruit trees, garden plants and medicinal plants are inte, national, because they have been transported from place to place by man. Right from the days of horseman of Steppes in USSR man has taken the seeds or the fruits from his own native country to a new country. Sometimes it is the new country where they prosper better than in the original country. Guava, which is supposed to be of South American origin grows very well in India, rather than in many other places. Brinjal which is native of India, produces very small fruits. But numerous varieties of it have been developed and cultivated in all parts of the world today.

Hybridisation of ornamental plants is practised by nursery men and seedsmen all over the world on a large scale. They also bring wild varieties, grow them in their gardens and green houses and improve their ornamental qualities. Most of the cultivated ornamental flowers have their wild parents. In natural conditions all wild plants produce various types and mutants. It is by these natural processes and selection, that several species of *Artemissia* and *Chrysanthemum* have come into existence and they are distributed over various areas where they prosper and find suitable habitats. They again multiply on large scale and select new strains. This process has been going on throughout the course of evolution.

It is also known that by tissue culture, orchids are commercially grown in Singapore and in Malaya and sent abroad all over for their beauty and fragrance. The average gardner in India has not learnt this new technique to bring forth new ornamental varieties. The common economic plants, their original home and the time since they are being cultivated are shown below :—

Name	Native home	Culture
Wheat (*Triticum sativum*) ..	Mesopotamia, Palestine	Prehistoric
Barley (*Hordum sativum*) ..	West Asia ..	Do.
Rice (*Oryza sativa*) ..	South-Central and South-East Asia	
Maize or Indian corn (*Zea mays*) ..	Central America, South America	Do.
Buckwheat (*Fagopyrum esculentum*)	Manchuria, C. Siberia	Modern
Walnut (*Juglans regia*) ..	E. Temperate Europe, Temperate Asia	Ancient
Almond (*Prunus amygdalus*)	Mediterranean basin, W. Temp. Asia	Prehistoric
Peanut (*Arachis hypogea*) ..	Brazil	Ancient
Coconut (*Cocos nucifera*) ..	India, Polynesia	Prehistoric
Kidney Bean (*Phaseolus vulgaris*)	South America	Do.
Lima Bean (*Phaseolus lunatus*)	Brazil ..	Ancient
Common pea (*Pisum sativum*) ..	South-West Asia	Do.
Be t (*Beta vulgaris*) ..	Mediterranean basin S. W. Asia	Do.

Name		Native home	Culture
Radish (*Raphanus sativus*)	..	Temperate Asia	Ancient
Turnip (*Brassica rapens*)	..	Europe, W. Siberia	Prehistoric
Carrot (*Daucus carota*)	..	Europe, W. Temp. Asia	Ancient
Sweet potato (*Ipomoea batatas*)		Central America	Prehistoric
Onion (*Allium cepa*)	..	Persia, S. W. Asia	Do.
Asparagus (*Asparagus*)	..	Europe, W. Temp. Asia	Ancient
Cabbage Kale (*Brassica oleracea*)		Europe ..	Prehistoric
Spinach (*Spinacea oleracea*)	..	Persia ..	Ancient
Cucumber (*Cucumis sativus*)	..	India ..	Prehistoric
Pumpkin, Gourd etc. (*Cucurbita pepo*):	..	North and South America	Ancient
Turban squash (*Cucurbita*)	..	South and North America ..	Do.
Sugarcane (*Saccharum of cinarum*)		India ...	Do.

5. Fruits and Fruit Culture in Maharashtra

Many fruits are grown in certain areas of Maharashtra, though not on a very large scale.

Fruits are generally classified as temperate and tropical fruits. Those which grow in temperate countries generally have less starch and more of acid, pulp or juice. Due to cold climate they do not ripen quickly, nor do they get rotten easily. The tropical fruits, on the other hand, contain large proportion of starch, sugar and pigments and they ripen quickly. Therefore, preservation of tropical fruits is not so easy as in the case of temperate fruits. In most of the countries there are huge refrigerator plants and they are used for preserving fruit. But this is not yet the case in India, Mango in Konkan ripen so quickly that quite an amount of fruit gets waste. In Nagpur where the citrus plantation is on a large scale they get easily spoiled for want of cold storage facilities. The same is true of strawberries at Mahabaleshwar and Panchgani.

Botanically a fruit is a ripened or modified ovary. It serves the purpose of storing the food material for seeds, and for their dispersal. This dual purpose of fruit is achieved in various ways in different fruits and consequently the edible parts are also different in them. Majority of the fruits have seeds, but attempts are being made to produce seedless fruits. Seedless fruits are obtained by parthenogenesis. As a matter of fact the world's best fruits are parthenogenetically produced.

Temperate fruits :

Since Maharashtra lies a little below the Tropic of Cancer, we do not have much cultivation of temperate fruits except in the hilly regions ruch as Mahabaleshwar and Panchgani. Commonly cultivated temperate ruits are : various kinds of berries such as strawberry, gooseberry, asp or rose berries and mulberry.

Strawberry.—This is largely cultivated in well manured soils at Panchgani and Mahabaleshwar, but more at Panchgani, because the plant does not tolerate much of rain and needs good drained terrain for its growth. The species cultivated generally is *Fragaria chinenis*. It is propagated vegetatively at the end of the rainy season. It produces many suckers during winter and begins to flower in February. The fruits are ripened by March when they are available in market. Practically the entire fruit of strawberry is marketed direct to Bombay, as the delicate fruit has very poor keeping quality, and there are no large scale refrigerators for its cold storage.

Gooseberry.—Another fruit commonly cultivated in hills is gooseberry *Physalis maxima*. It keeps well if not attacked by fungi because of the dry marcescent calyx. It is a delicious fruit very much liked and not very costly compared to strawberries. It comes mostly from Panchgani in the markets of Pune and Bombay.

Rapsberry or Roseberry.—This grows practically wild in Mahabaleshwar and hilly Pune area. During summer it produces small red fruits on tall creeping branches of roseberry plants looking almost like wild rose. There is not much cultivation nor market for it. So it is mostly used for preparation of jams.

Mulberry.—It is a collective fruit, grown in various areas, particularly where humidity is high in winter and early summer. The trouble with the plant however is that it has the highest number of varieties (about 250) and therefore, a known good yielding variety has to be maintained by vegetative propagation. There are two main varieties of mulberries, those which produce purple black reddish fruit, and those which produce long greenish fruits. Long greenish fruits are not much cultivated in Maharashtra, but more in the fruit producing area of Palanpur in Gujarat. This variety is tasty and sweeter compared to red fruited one, which is sour to begin with. Therefore, large scale cultivation of this plant is seen only in Mahabaleshwar, Dahanu, Kosbad area. It is cultivated in gardens elsewhere, but is not very popular. It is eaten as a dessert or used for preparing jams. Silk worms are grown on its leaves.

Grapes.—Another temperate fruit is grape. The culture of grapes is very popular in many parts of Maharashtra State. It was largely cultivated previously in Nasik area but the cultivation has now spread to other parts, such as Chikhali, Baramati, Pune, Neera, Sangamner, Tasgaon, Phaltan, Khuldabad where good grapes are produced. The grape vine *Vitis vinifera* is a good host for numerous diseases. The plant needs special methods of prunning and culture to get fruit in plenty.

Generally only one season—'spring', is used for collecting good fruit commercially. More than 250 varieties of different kinds collected from Afganisthan, Middle East, Russia, Iran, Spain, France, America and other grape producing countries are grown, depending upon the taste of the people and the suitability of season for the production of fruit. The grapes rot easily and also ripen quickly due to summer heat.

The popular varieties are *Bhokri* or Bukhari from the city of Bukhara in Uzbekistan, large variety of Anabeshahi, Selection-7, seedless Thomson and small *Kabul* variety of Chaman. By experience it has been found that if a variety such as *Anabeshahi* which has good fruits and heavy bearing is treated with gibberalic acid, the fruit becomes large and bearing also improves but loses taste as the sugar percentage goes down. Two

other popular varieties are *Kali Sahebi and Cheema Sahebi.* They have long oval fruit. They are also a good bearer. From the viewpoint of better flavour *Gulabi* is a good variety. It is cultivated only in a few places because it is not a heavy bearer. Its production is mostly confined to Chikhali area in Vidarbha, Pune and a few other places. Once the cultivation of grapes was very popular in Baramati area where the yield was highest in the world. But the plants having had many diseases the orchards got diseased and had to be cut down, and sugarcane grown instead. However, due to popularity and nearness to town, the grapes are still in demand and get good price. Older varieties like *Bukhari* or *Kandahari* or Bangalore Purple are not in demand much, though they produce good crop, but are not so tasty as other new varieties. The essence of grape culture lies in proper prunning and feeding vines from time to time and keeping them disease free.

Among the other temperate fruits, apples, cherries, pears, squince are important, but their culture is nowhere practised in Maharashtra, though there are a few stray plants. Dr. Lush had tried culturing apples and pears at Dapodi near Pune in the East India Shipping Company' Botanical Garden. The other fruits like apricot, plums have never been cultivated in Maharashtra as the climate and the seasons are not suitable for them. The other fruits which tolerate warm temperature climate are water-melons. They are mostly cultivated in sand and debris along the banks of large rivers where the manure in the form of debris get accumulated. The large long stripped or oval varieties are not cultivated as in Karnatak State. Several commercial firms supply seed, but the hybrid varieties which have the flesh red right upto core from rind are more popular. The other melons cultivated are fleshy Musk-melon or *Kharbuj.* These also have several varieties cultivated in different places along the river banks or in sandy beds, but the two best varieties used as table dessert are the *Kajla* grown on the rich alluvium at Sangam at Allahabad, and yellow fleshed varieties so commonly grown on the banks of Gomati at Lucknow and Banaras. The white fleshy varieties which are rich in sugary flesh called *Sarda* are not cultivated. Many varieties of cucumbers are cultivated,.and they grow well. Some of them grow in rainy season in Mawal region and have good keeping qualities, but it has green or yellow thick skin. Some varieties do not keep well being highly watery. However, wherever they grow they grow in abundance in the early summer season, but have no good preservation qualities.

Tropical Fruits :

Maharashtra being in sub-tropics, many tropical fruits grow well here, the most important of themare citrus fruits, mango, *papaya* and collective fruits like jackfruit, pineapple, custard apples, besides bananas, figs and miscellaneous fruits such as pomegranate, coconut and arecanut, *bor*, (jujube), lichi, guava, sapota, *ambada*, butter fruit (*Persia gratissima*) etc. Of these mango, banana, coconut, oranges, limes and lemons are important.

Coconuts are largely cultivated in orchards near the sea coast from Wapi down to Goa and further down in Malabar. The usual variety cultivated is tall but slow growing. It yields fruits not earlier than 8 to 10 years, but once started bearing it continues to bear for nearly 50 years. There are many varieties of coconut grown in different parts of our country. The large centres are Konkan, Karnatak, Malabar, Cochin and Puri. The production of areca-nut is not well organised as that of

coconut. Areca and coconut research is carried out at the Plantation Crop Research Station at Kasargod. They have produced some hybrid varieties of coconut which bear fruit earlier . They are short. They go in the market under the name Singapore varieties. A giant variety of coconut called Andaman or Ceylon giant is also cultivated but not commonly. The copra from coconut is required for oil and hydrogenated oil, but is not sufficient for purpose other than edible oil, Therefore they are largely imported from Andamans, Sri Lanka (Ceylon), Malaya, Singapore and such tropical islands as Maldive or Lakshadweep.

There is a controversy as to the origin of coconut, the South American genera related to coconut are small seeded species having fruits of the size of cherries, whereas coconuts in eastern countries have large fruits of *Cocos nucifera.* The origin of the areca-nut, is generally believed to be Indo-Malayan. Betel-nut grown on west coast of India, Assam, and is also imported like coconut. Coconut is believed to have come to India from Malaysia. According to Mahabale (1978) it is indigenous.

Citrus Fruits :

Citrus groups of fruits are cultivated best in Nagpur area where Tangerine like small oranges, as well as large oranges are cultivated on a large scale. Collection comes to Nagpur from surrounding areas and stored open in huge mounds like small hillocks and immediately auctioned. For want of cold-storage facilities, they are not preserved and many of them get spoiled in the process of transport. Some of the trading companies, therefore, prefer to extract citrus juice at Nagpur proper and then take it to their factories to process further for selling as orange juice.

The other area where citrus culture was common is Rahuri-Belapur area in Ahmednagar district, but due to Dieback disease on a very large scale most of the orchards have been cut down. It is also cultivated on relatively smaller scale round about Pune, but the climate of Nagpur which has both cold winter and warm spring, provides enough time to ripen the oranges slowly. Nagpur is supposed to be the best for the orange culture. Other fruits of this group are lemon and limes. Limes are cultivated in the gardens in a number of places around Rahuri, Pune, Aurangabad and Jalgaon, but on a small scale. There is no large scale production of limes in the State as in Uttar Pradesh, Punjab, Assam or Kadappa where cold is sufficient to increase their size and slow down the ripening. Lemons need early cold and hot climate later. Such climate is available around Ahmednagar, Pune and Jalgaon. At Nagpur, apart from suitable climate, alkaline soils containing lime are favourable. Lemon culture is not done on a large scale in Maharashtra State. When there is not much produce, they are imported from Gujarat, Mysore and Andhra and Madras.

Papaya cultivation is very popular in the basin of Tapi river in Jalgaon district. Many varieties of papaya are available. The Papaya development society at Lucknow has been working on them and spreading many interesting varieties. Most of them have flesh or pulp with orange colour. The giant varieties reaching the size of a round pumpkin are generally not cultivated because they are not tasty. Varieties from Singapore and Malaya have pink or deep orange flesh. They are also not cultivated. Cultivation of papaya is made for two purposes, one to get the fruit and the other to get papain. After the fruit has developed to a fairly large size and is rather raw and has not started ripening, incisions are made in the

skin or fruit wall. The latex comes out and gets dried on the fruit itself. It is scrapped off more than 2-3 times, dissolved in alcohol and crystallised into powder and sold in the market. It fetches good price. This is an industry in Jalgaon district near Jalgaon and Bhusaval.

A few collective fruits such as Jackfruit are not cultivated on a large scale. Stray trees are grown in hilly areas and also in the plains. They fetch good price. The cooking species of *Ficus, F. incisa* is rarely grown but not the other small fruited varieties which are so popular as vegetable in Uttar Pradesh. Another collective fruit is Pineapple. Pineapple cultivation requires well drained soil. In hilly areas of Ajra in Kolhapur it has been newly introduced and it produces good fruit but not yet on a large commercial scale as in Assam. Elsewhere it is not grown.

The custard apple has four different kinds of fruit . *Anona squamosa* or *Sitaphal* also called *Sharifa*. This grows wild generally in the hedges and on waste lands. The fruit is collected in October locally, but plantation on a large scale is done only at Khuldabad and around Aurangabad. Varieties with yellowish eyes and reddish eyes have been developed at Mehbubnagar near Hyderabad on Agriculture College farm and they are also introduced elsewhere. A cross between *Anona squamosa* and *Anona cherimolia* was effected at the Fruit Research Station—Ganeshkhind, Pune, and its fruit is now available in the market. *Anona muricata* is grown only in Bombay area. It has very large fruit but is not very popular. *Annona reticulata* (Bullock's heart) is grown as a stray tree in a number of places, but large sized fruits come only from the humid areas around Nasik, Aurangabad and Pune. The culture of pomegranates is done at Rahuri on Mahatma Phule Krishi Vidyapeeth farms and in Saswad taluka of Pune. The usual varieties are not the same but are imported. Those with pink or white grains are quite sweet but do not have large size of fruit.

Fig or *Ficus carrica*.—Fig is a typical tropical fruit but its cultivation is done only in the Pune area in Jejuri, Welhe, Khed, Shivapur and Saswad. The plant is very susceptible to several fungal diseases and, therefore, its cultivation is not everywhere successful. For its fruit production and ripening, vectors carrying pollen are necessary and only one particular variety has become stabilised in this area. It was imported from Iran and the Gulf countries. However, the most tasty and sweet variety used for drying purpose, namely Smarna fig variety or the Spanish purple black varieties are not grown in Pune. There is a green coloured fruit variety rarely available in Maharashtra and to some extent at Dharwar and Bangalore, but that is also not cultivated, probably due to the lack of vectors. This fig does not produce fruits of the proper size in Maharashtra.

Bananas.—Banana culture is an important industry in Jalgaon district. The largest centres of banana production are Raver, Yawal, Bhusawal, Jamner and Jalgaon talukas. As a matter of fact, about 60 per cent of the requirements of banana of the upcountry cities like Delhi, Lucknow, Chandigarh and cities like Bombay, Nasik or Pune in Maharashtra are met by the fruit that comes from Bhusaval. The fruit ripens quickly and has to be exported in good condition to distant places. If kept longer, it gets spoiled. There is no systematic work on the preservation, cold or otherwise, of bananas as that of Wardlaw on the Jamaican bananas sent to England. This fruit is exported to the Arabian countries where it is popular. The usual variety which is grown in Raver, Yawal and Bhusawal area is known as *Basarai*. This is a Cavendish banana

and a number of varieties and strains of it are available, the most popular ones being those with yellow and green rind, and those which develop spots on them during ripening. This is known as *Chitrasal*, mostly cultivated in Surat and Navapur area. The traditional difference between the banana and plantain is the colour of the rind ; when green they are called banana and those having yellow rind are known as plantains.

Another area where banana culture is successful is Vasai near Bombay. Gray in his *Botany of Bombay Presidency* (1885) mentions several varieties which were grown at Vasai in the past, but many of them have now died or discontinued, because they developed Bunchy top and other diseases which killed them. Others were killed by the attack of viruses and root fungi. Still the most successful variety at Vasai, *Rajeli* is being cultivated and has much demand. This variety produces less fruit compared to *Basarai*, and therefore is not very popular with cultivators. But it has good keeping qualities. They dry its fruit by very ordinary method of exposing to Sun drying, and then is sold in the market as *Sukeli*, or at times it is sold in powdered form.

The cooking varieties of banana are popular in the countryside. They are grown as stray plants in gardens. However, they are not grown on a large scale, nor are they used in every day use in meals as vegetable as in Andhra Pradesh or Tamil Nadu. As many as 122 varieties of bananas have been enumerated in Tamil Nadu, and there are also several good varieties in Mysore. One of the small fruited variety is known as *Rasabale* in Karnatak, another is called *Sahasrabale* in Gokak area, and a still other is called *Muttubale* in Kodaikanal hilly area. They all are practically hill banana varieties. Other banana products like banana powder are unknown in our State, because there is no banana research station anywhere in the State. There is a great possibility of increasing the banana production in the State but that needs well planned efforts and scientific study and market research. Certain varieties of bananas are easily made into powder which is a very nutritious food. A factory for producing powder of banana was started at Jalgaon, but due to local difficulties among the organisers, it was not a success. It is practically not functioning. There is no other place where there has been any factory for this purpose or research laboratory for banana research.

Like *Rasabale* of Mysore, a good table variety of banana in Maharashtra is *Sonkeli* or Apple banana. It is sweet, has good flavour and fragrance and also keeps long. Its cultivation is also very limited.

Grape fruit.—Grape fruit is a special variety of lime which produces fruits in bunches as in a grape bunch. It is highly nutritious and is much valued for its juice. The juice is slightly bitter and unless a taste is cultivated for it, it is generally not liked. Therefore, there are no orchards of this fruit as in America or Malaya, where it is cultivated on a large scale and juice is preserved for breakfast to begin with. Cultivation of this fruit is done at Anand in Gujarat. Stray plants are grown at Rahuri and in gardens around Pune and marketed in cities.

Mango.—By far the most important fruit of India is mango. There are innumerable varieties of this fruit throughout India. Most of them are derived from the same species *Mangifera indica.* The fruit is of variable size, shape, colour, flavour, aroma and pigments in the rind and pulp. The commonly cultivated and most popular variety Alphonso

needs humidity and heat for its good growth and ripening. Therefore, it is best grown in Konkan, especially in Ratnagiri, Devgad, Jaygad area. It is both exported abroad, and sent to Bombay and other places like Kolhapur, Delhi etc. Other variety which is equally popular is *Payari*. This has slightly thicker rind and its keeping quality is not so good as that of Alphonso. But its merit lies in its ability to grow anywhere on the Desh. In South Konkan, Goa, Dharwar and North Kanara this variety grows best due to suitable soil and climate favourable for ripening in season. The various varieties of mango have not yet been chemically or botanically well studied and fully classified. The analysis of some varieties was made by Dr. D. L. Sahasrabudhe. The mangoes in Bengal have been classified after fully studying by Mukherjee (1947). A scheme to do a similar work on Mango was initiated by Prof. S. P. Agarkar, but he was unable to complete it due to illness.

Broadly speaking, there are three kinds of varieties. The first variety e.g. Alphonso, ripens early, and fruits are brought into Bombay market. It continues to be much in demand for a long time. The same plant grown in Dahanu, Balsad region has more sweetish taste and is a little larger in size but has thicker rind than that of the fruit from Konkan. But the late ripening of Balsad Alphonso mangoes is helpful for price. After the Konkan Alphonso ceases to be transported to Bombay from Konkan due to monsoons, the Gujarat Alphonso fruit of Balsad, comes in Bombay market and fetches good price. Among the late varieties may be mentioned the varieties of North India such as Dashahari, Langda, Rajapur and the South Indian varieties such as Totapuri, Neelam, Benshan etc. They ripen right upto August and are available in the market, but still they are not so late as Shravaniya, the Punjab variety. Most of the upcountry varieties ripen late e. g. Shravaniya of Punjab. Their juice contains a high percentage of pectins. Some of the fruit from Andhra Pradesh especially early varieties like Baiganpalli come to Nagpur and Sholapur and other districts adjoining Telangana quite early, but these varieties are not available much, nor are they popular. In between these two late and early varieties, the country mangoes grown everywhere in every village, come in the market especially after one or two summer showers. They ripen very quickly due to heat and have to be consumed immediately. Patur in Vidarbha, and Kanhur, Kotul in Ahmednagar district are famous for good country mangoes ; in Sangli district Kadegaon and Khed-Shivapur in Pune district are also famous for mango. Their keeping quality is rather poor. However, in the Ghats and in certain hilly areas there are wild mango trees which produce late fruits upto August, but they never ripen. These are generally consumed for the sake of preparing pickles.

Now-a-days some fruit of mango is exported to England, Russia and other countries mostly from Bombay. All the mangoes that are greenish yellow in different regions have their separate flavour. There is a vast field for mango culture, but unless a special effort is made for research in methods of preservation, refrigeration and facilities for export, it may not be possible to increase the yield. Mango fruit ripens rather quickly. Some companies have their own pulp extracting plants and other equipment in mobile vans and they carry it to Ratnagiri and other places. There they extract juice and bring to Bombay for further processing to make beverages. There are few small canning plants for mango pulp and fruit canning. The industry as a whole is yet in a very elementary state. It can develop in rural areas as a small scale industry.

In Maharashtra the Assam mango *Mangifera assamica* which has rather bottle-like shape is not much cultivated, nor the large size fruiting variety *Malda*, or sweet starchy variety *Dashahari* which grow best round about Banaras, Patna and Lucknow. But there is no research station nor any society for the study of mangoes. The world famous author of the book "*The World was my Garden*", Fair child, had been to India, in Bombay and Pune, to collect seed of various varieties early in this century, and took the seeds and slips of various important varieties to South America and successfully grew them in Miami, where there is a huge garden of tropical trees the Huntington Park. Most of the tropical fruits of the world are grown there. Some Indian mango varieties are now cultivated in South America and Africa too. They develop their own flavour and are quite juicy. Their pulp is sold in the markets of England, America, Europe and Egypt around the Suez Canal towns. It is far less tasty than the pulp of the Indian mangoes. Dr. Cheema of Pune had made a lot of effort for exporting mangoes and for their preservation. The Ganeshkhind Botanical Garden developed by Woodrow became a Fruit Research Station, where several varieties of mangoes are cultivated and grafted successfully.

In Konkan area along the hilly slopes, where the rainfall and drainage are good, are full of cashewnut trees, introduced in the 15th century by the Portuguese invaders. They grow well here. The Portuguese had brought some other fruits also from Brazil, South America, but cashewnut is the one which has prospered well in Konkan climate. It is grown in Ratnagiri, Malvan, Vengurla, Sawantwadi, Goa and Ajra region of Kolhapur. It is also grown in Bombay. The coastal areas to the north of Bombay have them, but they do not produce fruit so abundantly as in Ratnagiri. A few factories for decorticating and processing the cashew seed and roasting are seen in Sawantwadi and South Ratnagiri towns like Malvan. The seed of cashewnut is used as dessert after frying.

Another fruit which is introduced in Sawantwadi area is Cocoa (*Theobroma cocoa*). This fruit also grows well in Konkan upto Bombay. It was introduced in Sawantwadi area first by Dr. Dalgado. He used to bring cocoa seeds from Sri Lanka. He grew them successfully in Sawantwadi area. In Bombay also the cocoa plant does well but there is no data on its bearing.

Among the other fruits Sapota (*Achras sapota*), Lichi are important. Sapota and Lichi grow best in Dahanu area and round about Kosbad, Bordi on sea coast. The plant needs equable climate and plenty of subsoil water for its growth and sandy soil. For ripening it also needs hot sunshine. Such conditions are available only in the area around Dahanu and therefore huge orchards of Sapota or *Chiku* and some of Lichi are grown there. Except two rainy months July and August, the fruit is seen on trees throughout the year and is exported to all places in the country. There are two varieties of it, those which produce round fruit and those that have oval conical fruit. The latter fetches good price. The round variety has more peps, the oval conical variety has smooth flesh and few peps. Lichi is also grown in gardens in Dahanu area mainly by the Iranian cultivators who are permanently settled there. The fruit is produced in small quantity. It is not so tasty, nor has the same flavour as that of fruit in Uttar Pradesh, Bihar or Assam.

Guava is a South American fruit and is popular throughout Maharashtra. Many varieties of it are seen, but the Lucknow variety which is grown has smooth pulp and not many seeds, or has only soft seeds. It is

supposed to be the best. The pink fresh varieties both round-oval and pyriform are available from Dahanu and Nasik. The country variety though a heavy bearer is not much cultivated. The fruits of a variety selected by Dr. G. S. Cheema is grown in orchards at Pune. Besides these main fruit trees, a number of other fruit yielding trees are also grown in Maharashtra.

Miscellaneous Fruits—Wild or Cultivated :

Bor or *Zizypus jujuba.*—There are both wild and cultivated varieties of this fruit throughout Maharashtra. It grows wild and produces abundant fruit in winter and comes to end by the beginning of summer. The varieties of *Bor* or *Ber* have round or oval shape. The latter are known as Banarasi. Their cultivation is seen at Mehrun in Jalgaon district and at Baner near Pune. At all other places the round varieties grow either wild or are cultivated. Main difficulty in *Bor* production is pollination. While pollinating, the insect lays eggs in ovary and larvae are developed inside the fruit. Most of the fruit is spoiled as the insect larvae develop. Consequently the fruit is not so popular. But some wild varieties do not possess them. The fruit is mostly wasted in rural area where it is not collected.

Myrobalans.—Among the wild fruits in rural areas Myrobalans must be mentioned. They are the fruits of *Terminalia chebula.* They are highly prized for tannin which is about 30-40 per cent higher than in any other tannin yielding material. It is also used in Ayurvedic medicines e.g. *Triphala.* There are half a dozen tannin extracting factories in the country one near Calcutta, another near Jabalpur, one in Maharashtra at Amba. The plant grows abundantly in Gaganbavda area, Bhor, Junnar, Tryambak areas, in Satpudas, in Khandesh and in Madhya Pradesh. The fruit is largely gathered by the local people and sent to Bombay for exporting to Germany, England and other countries where the tannin is needed for several purposes such as Calico printing, for softening water in boilers, in the preparation of ink and other preparations in which tannin is added as a preservative. There are two varieties of it, large oval and small round. Latter generally is found in this State ; and the oval and large, locally known as *Survari Hirda* is obtained from the hills around Jabalpur and Chhindwada. The other species of *Terminalia T. bellerica* also yields fruit containing tannin, but it is used mainly in medicine. The possibility of utilising this fruit for tannin extraction is not explored.

Some Other Fruits :

In addition, some other fruits are available in Bombay market They belong to cucurbit family. Some fruits are of wild trees of drier places, *Khirni* or *Rayan* (*Mimusops hexandra*). Some wild fruits grow in ghats. They are *Karvanda*, the fruits of *Carissa congesta.* They grow in abundance in hilly regions. They are popular but are not found in all places. *Chivar* are the fruits of *Elagnus latifolia.* They are available in ghats and Dangs. They are not very common in forests and grow only at high altitudes. Karmal (*Averrhoa karambola*) has sour fruits. They are also available seasonally, but are mostly used as an adjunct to vegetables. In Konkan region, another very important tropical fruit is *Garcinia indica.* The ripe fruits are collected, dried and extracted for coloured sour juice. The percentage of acidity is increased by adding this extract to fruits, dried and then sold in the market as *Amsul* or *Kokam.* Seed yields an edible fat solidifying at room temperature.

A regular survey of various wild fruits in our State has not been made. The fungi infecting fruits and vegetables stored in market have been studied by Dr. V. G. Rao of M. A. C. S., Pune. Available information of them by Dr. V. G. Rao is given in the Section on 'Fruit Rotting Fungi'.

A few other fruits, both wild and cultivated, are worthy of note but not used on fully commercial scale. They are the fruits of Mahuwa, *Rayan* or *Khirni*, Tamarind, *Bel*, *Kawath* or Wood apple, *Timbru* or *Tembu*, *Kamra*, Olive, *Charoli*, *Waghante*, Cappers or small fruits of *Capparis sepiaria* and other species.

Mahuwa are the fruits of *Bassia latifolia* found in large quantity in Vidarbha. Stray plants of it occur in other parts, but they are quite common in Satpudas in Khandesh. The flowers are collected and eaten by the Bhils and Kolis during summer when their food reserves get depleted. The fruit is fleshy, contains latex and some sugar, but not much. On drying it gets easily fermented due to yeast. Therefore, they are collected in large quantities by the tribals, who make country wine like the cashew wine.

In a similar way, they also collect fruit of Rayan or *Mimusops hexandra* which is plentiful in Thane and Dang forests, but elsewhere only in dry places such as near Ahmednagar. It is not very common. The fruit of this tree is a small berry highly nutritious and sweet. It is not used for making wine of any kind, but is eaten raw as soon as it is ripe. It comes from Balsad and Billimora areas to Bombay, Ahmedabad and in other markets. Its stalk is used for grafting Sapota (*Achras sapota*) plants in Dahanu and other places in nurseries in Thane district.

Tembu or *Tembru* is the fruit of *Diospyros montana*. The fruit is tasty somewhat like Kaki (*Diospyros kaki*), but does not have the same size as *Diospyros kaki*.

Kawath and *Bel* are very common in use. The fruit of wood apple or *Kawath* (*Feronia elephentum*) comes in the market after rainy season and fetches a moderate price, but its capacity to get preserved is not much as either the pulp gets dried, or there is fungal infection inside. Therefore, the fruit after it is ripe has to be used within a few days. Another fruit of a similar nature is that of *Bel* (*Aegle marmelos*). There are two varieties of it : the Banaras variety and the country variety. The fruits of country varieties are small and Banaras variety are relatively large. The pulp of country variety is not very sweet and therefore that is not used, except for medicinal purposes, for making *Sharbat* or jam. The Banaras variety on the other hand, has more sweet content, more pectins and sugars. It is used for making *Sharbat*. There are wild plants of *Aegle marmelos* in the hills of Satpudas and in drier areas of ghats in Khandesh and Aurangabad. The plant, however is highly medicinal and is much in demand by the Ayurvedic physicians for its pulp which is supposed to cure the disorders of stomach.

Jambhul or *Jamun*.—This is a fruit of *Eugenia jambolana*. Several varieties of this are found at different places but the taste is the same. Only size of the fleshy part of fruit differs. The fruit is much prized by the people who suffer from diabetes, but there is hardly any proof for it. The tree is not cultivated but wherever the seeds fall it grows. This tree is very hardy. Its timber is useful for making wooden base of certain musical instruments and furniture because of its compact timber. There are no nursery plantations of these trees anywhere in Maharashtra.

Equally wild is *Bassia latifolia* in Vidaibha especially Amravati. The trees of *Buchanannia lanzen* produce fruits which contain an oily seed sold in the market as Charoli. The trees of this are cultivated for oily edible seeds.

Olives.—An experiment to grow another oily seed bearing fruit in Maharashtra *viz.*, Olive (*Olea europea*) plant was made by Dr. Gibson. It is easily propagated vegetatively but it does not produce flowers and has no vector to pollinate. The result is that the tree remains barren all the time. The European olive is said to produce seed at Ranchi, but nowhere does it do so in Pune or Hiwre area or in other parts of India. There are two full-grown trees of it growing well in the Ganeshkhind Garden, Pune, opposite the Poona University building. They also are cultivated out of fancy elsewhere. The plant, though promising, has not been tried experimentally. Olives grow on calcarious soils and are much prized in Europe as a material for pickles, and their seeds for extracting olive oil useful as a cooking medium, and in the preparation of Margarine-like fats.

There are two other fruits grown in Alibag, Ratnagiri and Sawantwadi areas. They are the fruits of *Piper longum* and Jaifal or *Myristica fragrans*. From the previous records it is clear that both these plants were grown by Portuguese and Dutch in Konkan at a number of places, bringing vines from Malabar, but at certain stage the culture of peppers was given up. It has recently been restarted at Dapoli.

It will be seen from above that a large number of fruits which are wild have not received any attention at the hands of botanists, which they certainly deserve.

Tamarind.—Tamarind was known to Arabs and Egyptians as *Tamar-e-Hind* or Indian fruit used as spice. It was a favourite article of export from India. Amala or *Avale* is the fruit of *Phyllanthus emblica*. It is a rich source of vitamin C, and is used in a number of Ayurvedic preparations like *Chyavanprash*.

Several foreigners that came to India have brought them and got them introduced. That is how we have many fruits which are alien to India. Bombay, Surat, Goa and Cochin were the first places where they came. But no systematic effort is made to expand their cultivation or improve the quality or that of wild fruits. The subjoined statement shows the origin of different fruits from different parts of the world and time since they are being used. Seeds of Tamarind, *Bor* or Jujube have been found in archaeological sites which throw light on their history.

Common fruit trees and their origin

Fruit tree	Original home	Common since
(1)	(2)	(3)
1. Common apple (*Pyrus malus*)	Temperate Europe South-west, Asia South-west, not cultivated in Maharashtra.	Prehistoric
2. Common cherry (*Prunus sativum*)	Asia	Ancient

Fruit tree (1)	Original home (2)	Common since (3)
3. Raspberry (*Rubus idoeus etc.*) ..	North Temperate region.	
4. Garden strawberry (*Fragaria vesca*) ..	Chili, California	
5. Grape (*Vitis vinifera*) ..	Mediterranean Western basin, Western temperate Asia.	Used from prehistoric.
6. Musk melon (*Cucumis melo*) ..	India, South-west Asia, Tropical Africa.	
7. Water melon (*Citrulus vulgaris*) ..	Tropical Africa ..	Prehistoric
8. Orange (*Citrus aurantium*) ..	China, Cochin, East India.	Ancient
9. Lemon (*Citrus medica var Limon*) ..	India ..	Ancient
10. Banana (*Musa sapientum*) ..	South Asia, India ..	Prehistoric
11. Date (*Phoenix dactylifera*) ..	South-West Asia, Arabia, North Africa.	Prehistoric
12. Common Fig. (*Ficus carica*) ..	North Africa, East Mediterranean region	Prehistoric
13. Pineapple (*Ananas sativa*) ..	West Indies, Central America.	Ancient
14. Olive (*Olea europea*)	Asia Minor Greece, Italy.	Prehistoric
15. Cocao (*Theobroma cacao*)	Northern South America, Central America.	Prehistoric
16. Sago palm (*Metroxylon sagu*) ..	Sunda and Molucca Islands.	Modern
17. Bitter cassava (*Manihot utilissima*) ..	Northern South America.	Ancient
18. Tamarind (*Tamarindus indica*) ..	India ..	Prehistoric

6. Present crop pattern in Maharashtra

Crop pattern in Maharashtra has been studied by agronomists from time to time. The latest one is by Dr. M. V. Chavan and J. A. Patil, described in 1968 in *Deccan Trap Symposium, INSA* Bull. **48** : 10-18. The following one is mainly on the basis of information supplied by Dr. V. S. Rao of M. A. C. S. Research Institute, Pune. It will be seen that the crop pattern is changed from time to time, but curiously enough in certain parts of Maharashtra it has remained practically unchanged for years. For example, in the archaeological sites at Jorwe and at Newasa in Ahmednagar district, we get grains of bajra (*Pennisetum typhoideum*) and *kulith* or *lentil* (*Lens esculenta*). These grains of Bajra and lentil are easily comparable with grains cultivated in those parts

of Ahmednagar even today. This means that since the archaeological time, which has been estimated about 2300 years by carbon dating, there has not been much change in the crop cultivation. This speaks of great conservation on the part of people there. But this trend is now fast changing since the discovery of hybrid crops, which give high yield in cereals. Dr. Borlough of Sweden is the originator of dwarf hybrid crops, and in our country Professor M. S. Swaminathan. It has revolutionised the whole crop pattern of cereals. Accordingly the crop pattern has changed in Maharashtra also. At present the general trend is to cultivate hybrid dwarf variaties of wheat, bajra, jowar, rice, for high yields. They have rather loose ears. But at the same time, some of them are easily attacked by the local fungi and insects. Therefore, all precautions have to be taken for avoiding them by using fungicides and insecticides. They need high fertiliser doses and plenty of water. Without sufficient fertilisers and water they are not able to give higher yield. They also give less fodder as they are dwarf and have less foliage.

The crop pattern depends upon the climate of agroclimatic zones. Broadly speaking, the agroclimatic zones depend upon the annual rainfall and the type of soil that has to retain rain water. There is a zone of high rainfall in Maharashtra as indicated earlier, as well as certain other regions which are proverbially scarcity zones e. g. Sholapur, south and east part of Pune, Ahmednagar and parts of adjoining Marathwada districts. They lie more or less in scarcity zone. On the other hand, the parts little close to the main ranges of Sahyadris are known for high rainfall. The agroclimatic zones are accordingly classified as high rainfall zone, low rainfall zone and the scarcity zone. It is the drought period which is most dreaded by the agronomists, because of the uncertainty of yearly rains and its amount. On an average in about 35-36 years there is generally a bad period of scarcity. The greater part of Maharashtra, have a rainless period of about 7-8 months in a year. Therefore, the agronomic practices largely utilise the early growing varieties of crops. On the other hand much prized varieties of rice and also of jowar are generally the long season varieties. Some of the best varieties of rice in Maharashtra such as Jiresal, Ambemohor or new varieties of jowar such as Ashwini or Maldandi, Suwarnarekha are grown as Kharif season crop. In agronomically medium rainfall zone crops grown are generally Rabi. Therefore, the following account of the crop pattern is broadly based on these agroclimatic zones and the climatic conditions favouring them.

Deccan Region :

Deccan is mostly a low rainfall tract, and as such most of the cultivation is rain-fed. But in places served by the Deccan canals, crops fed by irrigation are taken. Thus, we find in Deccan two strikingly different crop patterns, (i) in rain-fed tract and (ii) in irrigated tract.

In the rain-fed area, jowar or bajri is the most important crop in the Kharif season. Seed is sown soon after the onset of monsoon rains. Jowar is intermixed with pulses like *udid*, *mung*, *chavali*, *tur* etc. It is a common practice to sow one or two lines of them after every 6 to 8 lines of jowar.

Kharif crop of jowar is followed by a rain-fed crop of wheat or safflower, growing on residual moisture after monsoon rains. In some places wheat and gram are intermixed in proportion of 3 : 1 with a sprinkling of mustard.

The irrigated areas of Deccan are mostly in the districts of Pune, Sangli, Satara, parts of Ahmednagar and Nasik. Sugarcane is the most dominant crop of all these areas. It is taken as the main crop and the succeeding and preceding crops are decided as and when the land becomes ready for sowing. Sugarcane is planted in three seasons. *Adsali* is planted during July-August, pre-winter is planted in October-November and *Suru* planted during January-February. These take nearby 18, 15 and 12 months, respectively, for maturity. Sugarcane is occasionally intermixed with *bhendi*, jowar, tomato, cucumber, chillies or onion. To achieve maximum returns out of the investment, the sugarcane crop is quite frequently rotationed.

Rice is grown in rotation with sugarcane in Kharif, followed by gram or wheat in Rabi.

Cotton is also grown as a Kharif crop with groundnut in the next Kharif season, thus giving a three-course rotation.

Another three course rotation is: sugarcane, Rabi jowar, Sann hemp.

In the Sangli-Satara districts, sugarcane is rotated with turmeric in Kharif, followed by jowar in the next Kharif.

In Pune and Satara districts, Kharif crop of jowar or bajri is followed by a Rabi crop of potato, whereas in Ahmednagar and Nasik districts, potato is taken in Kharif, followed by Rabi jowar or wheat.

In Nasik, Pune, Sholapur, Satara and Ahmednagar districts, in large areas onions are grown and also garlic in the Rabi season.

Tobacco is another important crop of the Deccan, particularly in Sangli district which along with Kolhapur district, accounts for 90 per cent of the total area under tobacco in Maharashtra. The tobacco is mostly of types suitable for *bidis*. It is mostly grown as a mono-seasonal crop without any rotation. Other minor crops of Maharashtra area are sesamum, which is grown in Kharif, Rabi, as well in summer and groundnut which is only occasionally grown as a summer crop.

Crop varieties grown in Deccan

Jowar	..	CSH-1, CSH-5, Swarna, Maldandi, Dukri.
Bajri	..	HS-1, HB-2, HB-5.
Sugarcane	..	Co-419, Co-678, Co-740, Co-775, Co-798.
Rice	..	Ambemohor-157, 159, 102, EK-70, Krishna-sal IR-8, TN-1, Jaya, Hansa, Padma.
Wheat	..	N-59, MACS-9 (for rainfed) and NI-146, Sonalika, Kalyansona, CC-464, Khapli (for irrigated tracts).
Gram	..	N-59, N-31.
Safflower	..	N-630, 628, 300, 7, NP-30, CT-11.
Groundnut	..	At-8-11, Karad 4-11.
Turmeric	..	Rajapuri and Karadi (soni).
Potato	..	Kufri chandramukhi, Kupri sundani.
Onion	..	Kharif-Niphad 5-2-8, 5-7-1, 123-7-1, 241, 2070-1.
Tobacco	..	Vars. P-19, K-20, K-49, G-6, S-20.
Sesamum	..	Nos-8, 85, 128.

Konkan Region :

Due to the high rainfall and hilly terrain the crop cultivation in Konkan area is of a limited nature, while plantation crops form the chief source of income of the farmers.

Rice is the most important crop of this region and is grown in Kharif season. Other millets grown in Konkan during Kharif are kodra and kodo millet (*Paspalum scrobiculatum*), *vari*(*Bhagar*)(*Panicum miliaceum*), and ragi or *nachani* (*Elusine coracana*) grown in the districts of Ratnagiri, Raigad, Thane and Kolhapur. The Kharif crop of rice is rotated with legumes or beans. They are sown during Rabi season. To some extent groundnut is also grown in Kolhapur district, but more in Jalgaon and Pune districts.

Another rotation practised is *nagli*(Pearl millet) for two years followed by sesamum or *til* for one year.

In the transitional areas of Kolhapur district, sugarcane is grown, followed by turmeric or tobacco.

Crop varieties grown in Konkan

Rice	.. Kolamba-42, Kolamba-540, Garvel-1-8, Kolavati-1-24, Dagda-627, Patri-6, Warangal-486, Jaya, Satya, Surya, Suhasini.
Sugarcane	.. Co-419, Co-67, Co-740, Co-775, Co-798.
Gram	.. N-59, N-31.
Groundnut	.. Kopargaon-1, Kopargaon-3, SB-11, AK-8-11.
Ragi	.. E-11, E-31, And A-16.
Sesamum	.. Nos. 8, 85 and 128.

Vegetable crops :

Wherever facilities are available, farmers take to inter-cropping under either canal irrigation *or* well irrigation. In many districts of Maharashtra vegetable crops are grown.

In Jalgaon, Satara, Beed, Nanded, Osmanabad and Nagpur districts coriander is grown on large scale both during Kharif and Rabi seasons. It is rotated with wheat, gram, jowar or onion or mixed with cotton, sugarcane, onion or brinjal.

Other vegetable crop mixtures are—

1. Cabbage and cauliflower in mixture or alternate rows and *knolkhol* in water channels.
2. Cabbage or cauliflower in beds or ridges, radish, beet root, lettuce in water channels.
3. Cucurbit mixture consisting of red pumpkin, bottle gourd, snake gourd, *khira*, bitter gourd and radish along channels.
4. Bhendi-jowar in alternate rows.
5. Sugarcane is farmed with *bhendi*, cucumber, chillies on sides of ridges.

Crop rotation in Khandesh (Jalgaon and Dhule districts) :

Because of the predominance of black cotton soils, the most important crop of Khandesh is cotton. It is grown both as a rain-fed crop and as an irrigated crop. The rain-fed crop is sown after the onset of monsoon i. e., June-July. The irrigated crop is sown earlier in May. Intercropping of cotton is a usual practice. Common among these are :—

(1) 1-2 lines of Ambadi after 10-15 lines of cotton with or without Ambadi (*Hibiscus sabdarifa*) sprinkling, and (2) cotton 8 lines and 2 lines of Kharif Jowar. In region where intercropping of cotton with soyabean is also recommended, the general recommendation is—two lines of soyabean in between two cotton rows. Cotton picking starts from October and extends up to December and January. The land remains fallow till the next monsoon. However, some take also a Rabi crop of wheat or jowar or gram if the cotton picking is over by December.

During the susbsequent Kharif season, depending on 2 or 3 years rotation, jowar or groundnut are grown.

Cotton-jowar (2 year rotation).

Cotton-jowar-groundnut (3 year rotation).

Cotton-groundnut (2 year rotation).

The jowar crop is generally intercropped with *udid, mung.*

In the north-eastern parts of Khandesh, wherever irrigation facilities are available, banana is successfully grown followed by a broadcasted crop of wheat on residual soil fertility.

To some extent, and on a limited area onion and chillies are grown depending on the availability of irrigation facilities. Onion is grown both in Kharif and Rabi seasons, whereas chillies are grown either Kharif as a rain-fed crop, or as a Rabi winter crop or even in hot weather, during February-March if irrigation facility is available.

Crop varieties grown in Khandesh

Cotton ..	Buri L-147 (G-hirsutum), Virnar, Gaoran-22.
Cotton—Gaorani-46.	(*G.-artsoreum*) AK-235 (derived from a cross H-420 × 487) and H. 4.
Jowar ..	Aispuri (Fodder-*cum*-gram variety for Kharif),
..	Gaoran (Kharif variety), CSH-1, CSH-5 and Swarna.
Groundnut ..	AK-12-24, Faizpur 1-5.
Gram ..	Chaga, N-59 and N-31.
Wheat ..	NI-146, NI-973, NI-747-19 or Kalyansona under irrigated conditions, and N-59 MACS 9 and NI 5439 for unirrigated conditions.
Tur ..	H-290-21, T-84, C-11.
Mung ..	Baisakhi Mung, Kopargaon Mung.
Udid ..	Sindkheda-1, D-6-7.
Chillies ..	Dharwar, Sankeswari-C2, and C-9.
Onion ..	In Kharif season Niphad 53, 404 M, 490.

		In Rabi season, Niphad 5-7-1, 123-7-1, 5-3-8, 2070-1, 241.
Soyabean	..	Clark—63, Monetta, Brangg Anker.

Vidarbha and Marathwada Regions:

As in Khandesh, cotton is an important crop of Kharif season. Sowing season is the same as in Khandesh, June-July for rain-fed crop and March-May for irrigated crop. Intercropping of cotton is a usual practice. The common practices are (1) cotton-10-15 lines with 1-2 lines of *tur*, or (2) cotton 10-15 lines with *tur* 1-2 lines with *ambadi* sprinkling, or (3) cotton 8 lines and Kharif jowar 2 lines. In recent years intercropping of cotton rows with two rows of Soyabean is also recommended.

The most important Kharif crop however is jowar which is grown in rotation with cotton under rain-fed areas. Other Kharif crops grown in rotation with cotton are *tur*, bajri and groundnut. If the cotton prices are remaining high or steady, cotton is grown successively for two Kharif seasons after which another rotation crop is taken. One variation of this is gram rotation, cotton-jowar-wheat rotation followed in some parts. The Kharif jowar crop is invariably intercropped with *udid, matki* or *mung*.

In some parts *mung* is taken as a short Kharif crop followed by a Rabi crop of wheat.

In places where cotton cannot be cultivated groundnut is taken as a summer crop, sown during the months of January-February, followed by a Kharif crop of bajri. Sometimes, the summer crop of groundnut is followed by rain-fed cotton in Kharif season and jowar in the next Kharif season.

Safflower is another Rabi crop grown mainly under rain-fed condition, because of its handiness. This is either grown as a sole crop or intermixed with the rain-fed wheat crop.

In the Marathwada region linseed is also grown in Rabi season and is rotated with wheat, gram, coriander, jowar, *udid* and *tur*. It is sown in October and harvested in January.

In Bhandara and Chandrapur districts of Vidarbha, rice is cultivated successfully in the Kharif season. To some extent turmeric, chillies, tobacco, linseed, sesamum are also grown.

Crop varieties grown in Vidarbha and Marathwada regions

Cotton	..	Buri-147, H-4, Varalaxmi, Gaoran-6, Gaoran-12, Gaoran-22 and Gaoran-46.
Jowar	..	CSH-1, CSH-2, CSH-5, Swarna, PSH-2.
Bajri	..	HB-1, HB-3, HB-5.
Tur	..	T-148, Tur-Hyderabadi, C-11, Pt-301.
Groundnut	..	Spanish improved, Kopergaon-1, Kopergaon-3, improved, Small Japan.
Wheat	..	N-59, MACS-9, (for rain-fed conditions) Kalyansona, NI-5437 (for irrigated conditions).
Udid	..	Sindkheda-1, D. 6-7, Udid-55.

Gram	..	Deccan and Warangal.
Safflower	..	N-7, 300, 628, 630, NP-18, NP-30, CT-11.
Rice	..	EB-17, Triple Burma, EB-27, Tuljapur, Jaya IR-8 Hansa, Padma, Karjat 184.
Tur	..	Gujarat or local variations.
Mung	..	Kopargaon Mung.
Linseed	..	Malshiras-10, Sholapur-36, N-3 and N-55.
Soyabean	..	Clark-63, Monetta, Bragg.

Thus the present crop pattern in Maharashtra is not what it was some years ago, and it is probable that it may also change somewhat in future. But since the rainfall on the whole, and the soils are varied—some black cotton, some sandy mixed or lateritic, not much change is expected. The varieties may change after trials, and may be cultivated with some old disease resisting varieties evolved through long years by experience. Pattern of crop plants in pre-historic and historic times is described in the following pages and may be compared with the present one to look for improvements.

7. Ancient crops in Maharashtra

There are several archaeological sites in India as well as Maharashtra. From these some foodgrains and seeds have been recovered and their account is given by Dr. Vishnu Mittre in *Transactions of Bose Research Institute* **21** (3), 1968, and that of grains in Maharashtra has been given by Dr. M. D. Kajale at the first Geophytological Conference, Lucknow, 1975 (*Geophytology*, Vol. 7 : 98-106, 1975). In Maharashtra they are found at Bhatkuli in early historical period, at Amravati and Paunar (400-500 B. C. to 3-6 centuries A. D.), at Newasa and Soyegaon in Ahmednagar district and at Inamgaon in Pune district. The study of archaeological plant remains throws light on the crops, trees and agriculture in those prehistoric times, both in India as well as in Maharashtra. The following Tables give the foodgrains and their popular names enlisted by Dr. Kajale (1975). It will be noticed that they belong to different periods as indicated in Table IX-B-7·2.

TABLE IX-B-7·2

Showing List of Charred Grains from Archaeological Sites at Newasa Compiled by M.D. Kajale, 1975.

List of grains with popular names

Hordeum vulgare Linn.	Barley
Oryza sativa Linn.	Rice
Triticum ct. sphaerococcum Pere.	Wheat
Paspalum scorbiculatum Linn.	Kodo Millet
Eleusine sp.	Finger Millet
Pennisetum typhoides Stapf. of Hubbard	
Sorghum sp.	Sorghum Millet
Carthamus tinctorius Linn.	Safflower
Phaseolus mungo Linn.	Udid
Phaseolus sp.	Green gram Black gram

Dolichos lablab Linn.	Hyacinth Bean
Lens esculentum Moench.	Lentil
Pisum arvense Linn.	Peas
Cicer arietinum Linn.	Chick pea
Lathyrus sativus Linn.	Grass pea
Zizyphus sp.	Indian *Jujube*
Tamarindus indica Linn.	Tamarind

TABLE IX-B-7·2

STRATIGRAPHIC DISTRIBUTION AND AGE OF CHARRED GRAINS OBTAINED FROM NEWASA AND OF THOSE IN OTHER COUNTRIES.

Grains	Chalcolithic Period I 1500 B. C. to 1000 B. C.	Satavahana Period II 150 B. C. to 50 B. C.	Indo-Roman Period III 50 B. C. to 200 A. D.	Muslim-Maratha Period IV 1300 A. D. to 1800 A. D.
(1)	(2)	(3)	(4)	(5)
Barley	—	..	•	
Rice	—	•	•	—
Wheat..	•	•	•	•
Kodo-millet	•	•	•	•
Finger millet ..	—	•	•	—
Pearl millet	—	—	•	—
Sorghum millet ..	—	—	•	•
Safflower	—	—	•	•
Green gram	•	•	•	—
Black gram	—	•	•	—
Hyacinth pea.. ..	—	..	•	—
Lentil lens	—	•	•	—
Field pea	•	•	•	•
Chick pea (Gram) ..	—	—	—	•
Grass pea	•	•	•	—
Indian Gram ..	•	—	•	•
Jujube Ber	..	..	—	—
Tamarind	—	•	—	—
Unidentifiable seeds	—	•	•	•

• Present —Absent

These grains were used as food by the people from chalcolithic times almost to the present time at Newase and around. The Chalco lithic culture was succeeded by Satavahana culture dated 150 B. C. to 50 B. C.

Some unidentifiable fruits were also found. At Newasa and Jorwe tamarind seeds were found. Indo-Roman culture was spread in India from 50 B. C. to 200 A. D. It also showed the charred grains enlisted above. But no *Sorghum* or safflower seeds appear to have been introduced newly in the cultural phase of Indo-Roman culture. In India tamarind seeds have been found in the tombs dating 2000 B. C.

At Kolhapur also charred Sorghum and tamarind seeds were found. There are several sites of Satavahanas such as Bhokardan, Ter, etc. Each of these sites has its own flora : For instance at Navadatoli near Maheshwar in Madhya Pradesh seeds of pigeon pea *Cajanus cajan* and Lentil seeds were found in abundance. Even at Maheshwar in Madhya Pradesh near Indore, and at Newasa, oilseeds of safflower were found. However, safflower or its seeds do not suggest any significant climatic change. The grains found here are mostly *Paspalum scorbiculatum* L., wheat grains, coriander seeds, grains of Barley (*Hordeum vulgare*). All these grains found here are carbonised or semi-carbonised. Sorghum also is now reported in Maharashtra, from Inamgaon on the bank of the river Ghod in Pune.

Some pollen grains have also been found from some sites such as Higaon, but not elsewhere. The relative ages of the chalcolithic to early historical time is as follows :

Newasa—Late historical	1200 B. C. to 1318-1758 A. D.
Kolhapur	Late historical 100 A. D.
Bhatkuli (Amravati Dist.)	Early historical period.
Paunar	Late historical 400-500 B. C. to 3-6 A. D.
Soyegaon Chalcolithic	1345-1145 B. C.
Inamgaon-Chalcolithic	1275-940 B. C.

The study of archaeological plant remains such as foodgrains and seeds throws light on the crops, trees and agriculture in those prehistorical days in India as well as in Maharashtra. Several important archaeological sites on the banks of rivers such as at Jorwe, Newase, Ter, Inamgaon, Pune have been thoroughly studied by Dr. H. D. Sankalia of the Deccan College, Pune and his associates. The list of grains given by them and by Kajale above contains Bajari (*Pennisetum typhoides*) and *Lens esculantum* (Masoor). They are still being cultivated in the same areas for ages. The age of some of these carbonised grains by carbon dating method was found to be about 1200 B. C. which means they have had been cultivated for more than 2000 years. This is rather interesting as it suggests that the crop pattern in Maharashtra till recent time is not much changed and is conservative.

The crop pattern as it is today has been given earlier. If it be compared with the one which was in existence before 25 years ago, it will be seen that it is now largely made up of new hybrid varieties of bajari, wheat, rice etc. The traditional varieties of grains are also cultivated side by side with the new ones for their capacity for resistance and the flavour liked by people. The hybrid varieties are chosen because of their high yield. However, it is necessary to note here that Maharashtra being largely dependent on rains, the rain-fed varieties and short season ones are more important in dry farming areas. It is only now that serious efforts are being made to develop such varieties as could grow successfully despite low and erratic rainfall. One such very successful high yielding variety

of wheat grown on rain water only has been developed by the Maharashtra Association for the Cultivation of Science (M. A. C. S.), Pune, under the name MACS-9, and is now distributed to farmers. It is a suitable variety for drier areas of Maharashtra, Andhra Pradesh, Mysore and part of Madhya Pradesh. The rain-fed varieties of other crops are yet to be developed. Some new varieties of rice have been developed at Ratnagiri, Kosbad, Dapoli, *viz.*, Bluebell variety or its derivatives by Dr. M. S. Pawar. In Mulshi, Bhor and Nasik areas new varieties of rice similar to *Ambemohar* or *Kamod* have been developed. New varieties of groundnut are developed at Oil Seeds Research Station at Jalgaon.

8. Origin of Agriculture in India *vis-a-vis* Maharashtra.

Origin of Agriculture in India is unknown, but evidence is now forthcoming of the antiquity of Neolithic culture. In that the local crop of millets, rice was also grown, but their exact origin is still unknown. During Mesolithic period animal domestication seems to have begun. It must be prior to plant domestication. Wild grasses were reaped and some were cultivated for food. Cultivation of wild grasses for food as cereals is done even now by the hill tribals e. g. wild rice (*Oryza sativa*), or in *kumali* or shifting cultivation. Extra-local crops entered India at the extreme north-west and got diversified in various cultures at different places west to east and north to south. Rice entered Ganga plains from the north-east where some wheat, barley cultivation was already in existence. During the later ages wheat and barley spread down to south. Cultivation of wild grasses, legumes such as *Dolichos biflorus* or *Phaseolus mungo*, *P. radiatus* seems to have been practised and domesticated in India (Maharashtra and Madhya Pradesh) in Neolithic period and in the post-Neolithic period (See Vishnu Mittre, J. *Human Evolution* 1978, 7 : 31-36.)

9. Economically Important Plant Families

We shall now consider the economically important Angiosperm families in Maharashtra State. Out of 117 families in it, economically important families are only about 15. Complete economic botany of Maharashtra has not been studied, although the various government publications and Reports on the marketing of crop plants and commodities are published from time to time. The Agricultural department also published data regarding the crop plants periodically, and since their production and prices change from time to time, they have not been considered here. A complete marketing survey of the fruits and fruit vegetables at Bombay was made by Prof. P. V. Bole then of the St.Xavier's College, Bombay, giving account of the botany of the fruit vegetables, their marketing conditions in Crawford market in Bombay.

Timber trees form an important section of Economic Botany. The *Gazetteer of Bombay State, (Revised Edition), Botany Part II-Timbers*, by Prof. S. P. Agharkar was published in 1957. It gives account of all the Timber species. Prof. S. P. Agharkar has also given a comprehensive account of the Medicinal Plants of Maharashtra in the *Gazetteer of Bombay State, Botany (Revised Edition-1953), Part I-Medicinal Plants*. Cultivation of medicinal plants is now done in Jawaharlal Nehru Udyan or Botanical Garden of Ayurvedic Medicinal Plants at Kothrud near Pune. A large number of medicinal plants are used in the indigenous systems of medicine. However not much work has been done on their cultivation, ecology, analysis or pharmacognostic characters. The last chapter of *Medicinal Plants of*

Bombay by Agharkar (1953) summarises important botanical aspects yet to be tackled successfully.

We shall therefore, consider here other economically important plants. The figures of total revenue from forests in Maharashtra are given below, obtained through courtesy of Dr. I. M. Qureshi, Chief Conservator of Forests, Maharashtra State.

1. Gross revenue from forests in Maharashtra State—

Year			Gross Revenue (Rs. lakhs)
1978-79	..	...	5,228.32
1979-80	..	..	5,219.53

2. Gross revenue from forests in Chandrapur district—

Year			Gross Revenue (Rs. lakhs)
1978-79	...	...	1,707.54
1979-80	..	...	1,858.65

The study of flowers commonly used by people has always attracted the attention of botanists. Brev. Col. Dr. K. R. Kirtikar has given an interesting account of the common flowers used for worship and also of the poisonous plants occurring in Maharashtra and their poisonous properties in the *Journal of the Bombay Nat. Hist. Soc.* early Vols. before 1900 and published separately in (1898).

Study of the various families shows that all families are not of equal importance from the viewpoint of Economic Botany. Amongst the medicinally useful families, the following are rather important : Rubiaceae, Compositae, Leguminosae, Labiateae, Celastraceae, Verbenaceae, Plumbaginaceae, Solanaceae, Flacourtineae, Combretaceae, Gentianaceae, Asclepiadaceae, Apocynaceae, Convolvulaceae, Piperaceae Euphorbiaceae, Liliaceae, Palmae and Gramineae.

From the viewpoint of timbers, important timber yielding species belong to Rubiaceae, Verbenaceae, Combretaceae, Anacardiaceae, Meliaceae and Leguminosae. Some timbers are used for specific purposes, as the qualities and properties of various timbers differ considerably, their use also accordingly is varied and restricted to certain purposes. The data regarding the yield from various species is not available but the total revenue that accrues to the State Government is known and has been given on last page, figured wood of teak fetches 3-4-times prices for *Tectona grandis* wood of Alapalli in Chandrapur.

Among the miscellaneous forest products a special mention must be made of the spices belonging to families Piperaceae, Umbelliferae, Rutaceae, Gramineae, Acanthaceae, Celastraceae. Cultivation of spices like black or white pepper *Piper nigrum* or *P. longum*, Nutmeg (*Myristica fragrans*) *Allangium lamarkii* is not much practised, but is worth doing. Other spices *Clausena indica, Garcinia indica* grow wild and are collected

mostly from Konkan and Ghat regions. The cultivation of cloves (*Eugenia caryophyllata*) is tried at times, but as there is no pollination, no cloves are obtained. The same is the story of Olive (*Olea europea*). It grows well at Pune and at hill stations, but it does not bear fruit, as the vectors which bring about pollination are not there. The *Kokum* or *Garcinia indica* grows at Matheran, Konkan and Ratnagiri hill tops where it grows well, and also *Olea nilgirense*, but it is not known to yield fruit from which edible oil could be extracted. The cultivation of *Olea europea*-European olive is done at some places like Ranchi, and it is reported to be successful. It is worth attempting. The cultivation of African Oil Palm (*Elaeis guineensis*), *Cocos coronata* of South America, *Stereospermum oleifera* is also worth trying in different regions of Konkan, especially where weather is hot and there is sufficient moisture in soil and, in air.

Palm as a whole is an important economic family, but not much attempt has been made for its cultivation. Cultivation of *Metroxylon sagu*, Sago Palm is possible in plains in Konkan, but it does not appear to have attracted attention of the botanists. Similarly, there are other plants of economic importance which possibly could be cultivated in different regions of the State.

Regarding the fibre yielding plants, not much can be said for want of any data. Plants such as *Caryota, Boehmeria, Hibiscus* and other wild fibre-yielding plants like *Malachra capitata, Thespesia lampas* need trials. *Corchorus olitorius* and *C. capsularis* were tried in South Ratnagiri and their cultivation was reported successful. Tapioca, the root of which is a staple food of the people in Kerala does well in many regions of Maharashtra. It needs plantation on large scale and trials to succeed industrially.

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10. Honey and Honey Bee Plants

Honey is the sweet fluid collected from the Bee hives. It is stored by *Apis mellifera, Apis cerana, Apis florea, Apis dorsata* etc. from garden as well as wild flowers. There are three species of bees in Maharashtra and bee-keeping is a popular cottage industry in certain parts. The very common bee, from the hives of which the honey is generally collected, is *Apis cerana* belonging to the Order *Hymenoptera* of Insects. It is a medium size bee compared to *Rock Bee, Apis dorsata* which is large. The latter builds its hives in distant jungles, away from human habitation, attached to some high building, trees, boulders or rocks. It is easily provoked with the least disturbance and attacks any moving object nearby. There is a third bee. It is a very small bee *A. florea*

The common bee *Apis cerana* collects nectar from garden as well as wild plants generally in the hills and forests. There are large populations of these at Mahabaleshwar, Melghat, Sagar, North Kanara, Phonda Ghat, Kodaikanal, Ootakammund etc. The small bee *A. florea* is found in coastal regions. There is territorial distribution among the bees. They visit the same area and same flowers to collect the nectar from same plant species. The little bee *A. florea* occurs in tropical coastal plains.

Honey bees are polytropic, but once a source is selected at any time, they visit that source and exhibit constancy of 'floral fidelity', as long as those flowers last, ignoring other sources. It carries pollen in baskets on its legs and on its proboscis. Due to its very hairy body it carries a large number of pollen grains when it visits a flower and then another to collect either pollen or nectar. It brings about cross pollination as it moves from flower to flower. A bee has instinctive capabilities to distinguish sources of food, and never makes a mistake. Honey bees rarely collect pollen poisonous to man or to themselves. They avoid such flowers. They also collect sugary fluid secreted by smut fungi like smut of Sorghum (Jowar), and secretions produced by aphids or from the cut end of sugarcane etc.

There are two flowering seasons for wild plants in Maharashtra and in India, one short season October-November and second a long one in period from March to June till the advent of rains. During the first part of *Kharif* season, bees visit the crop plants for their food and migrate in rainy season to drier areas. Thus they have developed the habit of migration to avoid starvation. On an average of 55 kg of honey is obtained from a hive in a year. Foragers or worker bees have to visit the flowers at least 100 million times to accumulate 1 kg of honey. On an average 3 mg of nectar is available from each flower.

As the different flowering plants come in blume at different times, it may appear difficult to find from which flowering plants the bees have gathered nectar. But the study of local flora helps in solving the problem. Examination of pollen grains of plants in the vicinity and those in the honey, is a practical method to identify the plants of the beesforager in a particular season. Nectar is collected generally from flowers but sometimes also from extra-floral nectaries as in species of *Terminalia* and cotton, etc.

Honey has many medicinal properties according to Ayurvedic and Allopathic systems. It is highly nutritious. In *Ayurved* a lot of properties of good and old honey are described.

The presence of nectar serves as a bait to pollinaters and probably helps the pollen tubes to germinate in ovary and style till the ovules are reached.

Since the bees live on flowers and nectar, they need a large amount of flora for pasturage. Many indigenous plants in the jungle, forests, in valleys serve as the main sources of bee pasturage. Many exotic plant species have also been introduced in the country for this purpose. Some of the important bee pasture plants in Maharashtra are given elsewhere in this book. Bees increase the yield of crop plants. It has been shown that by keeping bee-hive lines in crop field, the yield of seeds and fruits increases greatly. (See Deodikar and Suryanarayana, 1977, *Advances in Pollen and Spore Research*, **2** : 263). Breeding of

bees, is now a special branch of Agriculture. The total production of honey in India is given in Khadi and Village Industries Commission Reports annually.

Many crop plants such as cotton, maize, mustard, *bhendi*, (*Hibiscus escnlentum*) are important sources of bee pasturage in both Kharif and Rabi seasons, especially in Kharif season. Several fruit trees such as mango, oranges, limes, Lokat (*Eriobotrya*), citrus fruit trees also provide nectar. Some kinds of honey have good aroma, e. g. Rose honey of Mahabaleshwar.

Honey consists of 70-80 per cent dextrose and levulose, 20 per cent water and 1.4 per cent sucrose and other substances. It also contains a small amount of resinous material. Honey contains saturated sugars.

Since the bees live on nectar in flowers a large amount of flora is necessary for their pasturage. Many indigenous plants in forests are the main source of pasturage. It is, therefore, important that the bee pasturage trees be protected. Some exotic plants have also been introduced. Several plants in the gardens such as *Althea*, Antigonon, safflower, crucifers, beans, balsama, cabbage, raddish, linseed, mango, gulmohor, bombax are important sources for bees to collect nectar, besides wild plants.

List of plant sources of Bee pasturage—garden and wild—are given in subsequent pages.

With the establishment of the Central Bee Research Institute at Pune by the Maharashtra Village Industries Board,a large number of Bee Research Centres have been opened. The pollen is studied there to locate sources of honey and a co-ordinated programme of research is conducted under the auspices of Central Bee Research Institute at Pune. A separate journal is also run by them named as *Indian Bee Journal.* Some Research Laboratories are located at different hill stations. They run for nearly 9 months in a year, except in the months of rainy season. They have training centres for Honey and Apiary Management. Many plants suitable as Bee fodder for increased honey, indigenous as well as exotic, are cultivated. Regular studies on physico-chemical properties of honey from different plants, in different seasons, and places are carried out. The following Table No. IX-B-10.1 gives main physico chemical properties of honey gathered at Mahabaleshwar determined by Dr. Phadke, Director of the Central Bee Research Institute, Pune.

It will be realized from the above that Bee and Apiary Industry has a considerable scope in rural areas and in the hilly humid or semi-humid areas of Sahyadri and Satpudas.

TABLE IX-B-10.1

PHYSICO-CHEMICAL COMPOSITION OF HONEY IN MAHABALESHWAR (AFTER P. R. PHADKE—*Ind. Bee. Jour* 24 : 59-65, 1962)

S. No.	Floral source	Karvi	Whayti	Karwi	Pisa	Burambi	Akhra	Jambul	Hirda	Gala
1	Moisture	18·33	19.11	18.25	19.30	18.86	19.57	18.15	17.13	16.09
2	Specific gravity ..	1.41	1.405	1.405	1.407	1.409	1.415	1.42	1.415	1.425
3	Direct polarisation ..	2.18	—1.12	—0.54'	—2.30'	—1.48'	—0.36'	—1.48'	—1.48'	—2.12'
4	Total dissolved slides	79.75	79.00	79.75	78.25	79.25	79.00	80·00	81.25	82.25
5	Total sugars	77.82	78.67	79.13	73.50	76.24	77.18	78.25	79.06	79·89
6	Non-reducing sugars..	11.36	0.55	3.36	4.06	4.80	1.80	2·44	3.70	2.08
7	Reduc ng sugars ..	66.46	78.12	75.77	69·44	71.44	75.38	75.81	75.36	77·80
8	Levulose ..	38.29	39.80	41.19	35.71	39.12	40.18	39·72	41.30	42.54
9	Dextrose	28.17	38.32	54.58	33·73	32.27	35.20	36.09	34.06	35.36
10	Ratio L/D	1.36	1.08	1.19	1.06	1.21	1.14	1.10	1.21	1.20
11	Dextrins	2.14	1.08	0.50	1.98	1.37	1.58	1.15	1.49	1.89
12	Acidity	0.173	0.112	0.156	0.113	0.093	1.138	0.063	0.037	0.062
13	Ash	0.298	0.138	0.128	0.478	0.113	0.175	0.198	0.014	0.167
14	Proteins	0.817	0.579	0 29	1.135	0.389	0.546	0.485	0.61	0.417
15	Undetermined ..	1.92	1.89	2.00	2.38	1.39	1.43	1.85	1.62	1.66
16	Fiehe's test	—ve	—ve	—ve	—ve	—ve	—ve	—ve	—ve	—ve
17	Colour	Greenish amber	Light yellow	Light yellow	Dark	Light	Light amber	Amber	Light yellow	Pale yellow

BEE FORAGE (WILD PLANTS)

Acacia sinuata (Lour) Meev ..	Mimosaceae ..	Feb.-Mar.
A. nilotica (Linn) Del	Mimosaceae ..	Sept.-July
Actinodaphne angustifolia Nees ..	Lauraceae	December
Aegle marmelos (L.) Corr. ...	Rubiaceae	June
Ailanthus excelsa Roxb.	Simarubeaceae ..	December
Azadirachta indica A. Juss. ..	Meliaceae	Mar.-Apr.
Bombax ceiba L.	Bombacaceae ..	Jan.-Mar.
Borassus flabellifer L. ..	Araceae	December
Butea monosperma (Lamk) Taub	Papilionaceae ..	Jan.-Mar.
Calophyllum inophyllum L. ..	Cluasiaceae ..	Nov.-Dec.
Canthium parviflorum Lamk ..	Rubiaceae	Apr.-May
Cassia fistula L.	Caesalpincaceae ..	May-June
Cennamomum zeylanicum Bl. ..	Lauraceae	Dec.-Jan.
Dalbergia sissoo Roxb.	Popilionaceae ..	Feb.-June
Dillenia pentatagyna Roxb. ..	Dilleniaceae ..	Mar.-Apr.
Diospyros embryopteris and other species.	Ebenaceae	Mar.-Apr.
Ehretia acuminata R. Br. ..	Ehretiaceae	April
Elaeocarpus spp.	Elaeocarpaceae	
Emblica officinalis Gaerth ..	Euphrbiaceae ..	Mar.-June
Erythrinad indica Lamk	Papilionaceae ..	Feb.-Mar.
Flacourtia indica (Burm.f.) Meer	Flacourtiaceae ..	Feb.-Mar.
F. montana Grah.		Nov.-Dec.
Garuga pinnata Roxb.	Burseraceae ..	Mar.-June
Grewia asiatica L.	Tiliaceae	
Holigarna grahamii (Wt.) Hk.f. ..	Anacardiaceae ..	Jan.-Feb.
Hopea wightiana W. & Arn. ..	Dipterocarpaceae ..	Mar.-June
Limonia acidossima L.	Rutaceae	Feb.-Mar.
Syzygium caryophyllatum (L.) Alston and S. cumins. ..	Myrtaceae ..	Apr.-May
S. zeylanicum (L.) DC	..	Feb.-Mar.
Lagerstroemia lanceolata Wall	Lythraceae ..	Apr.-May
Litsea stocksii HK. f. ..	Lauraceae ..	Oct.-Nov.
Madhuca indica Gmel. ..	Sapotaceae ..	January
Memecylon umbellatum Burm. ..	Malestomaceae ..	Feb.-Mar.
Morinda tinctoria Roxb. and *citrilolia* L. ..	Rubiaceae	
Olea dioica Roxb. ..	Oleaceae ..	Feb.-Mar.
Pongamia pinnata (L.) Pierre ..	Papilionaceae ..	Mar.-Apr.
Premna coriacea Clarke ..	Verbenaceae ..	Apr.-May.
Prunus zeylanica (Wt.) Mig. ..	Rosaceae ..	November
Salix tetrasperma Roxb. ..	Salicaceae ..	Oct.-Nov.
Sapindus laurifolius Vahl. ..	Sapindaceae ..	May-June
Strychnos nux-unmica L. ..	Strychnaceae ..	Mar.-Apr.
Symplocos deddomei Clarke ..	Symplocaceae ..	Nov.-Feb.
Syzygium cumini (L.) Skeels ..	Myrtaceae ..	Mar.-Apr.
Terminalia alata var. *nepalensia* Burm.	Combretaceae ..	Apr.-June
T. arjuna Wt. and Arn. ..	Combretaceae ..	Apr.-June
T. bellerica (Gaertn.) Roxb. ..	Combretaceae ..	Apr.-June
T. chebula Retz. ..	Combretaceae ..	Apr.-June
Toona ciliata Roem. ..	Meliaceae ..	Apr.-June
Vateria indica L. ..	Dipterocarpaceae ..	Apr.-June
Xeromphis spinosa (Thumb.) Keay	Rubiaceae ..	Apr.-June
Zizyphus mauritiana Lamk. ..	Rhamnaceae ..	Oct.-Nov.

Z. rugosa Lamk.	Rhamnaceae	Jan.-Mar.
Asparagus racemossus var. *javanica* Baker.	Liliaceae	
Cocos nucifera L.	Palmae	
Borassus flabellifer L. ..	Palmae	
Areca catechu L. ..	Palmae	
Arenga wightii ..	Palmae	
Ensete superbum Cheesemann.		

Common Garden Plants as Bee Forage

Allium cepa L. ..	Liliaceae	
Althea rosea Cav. ..	Malvaceae ..	Jan.-Dec.
Antigonon leptopus Hk. and Arn.	Polygonaceae ..	July-Nov.
Brassica campestris L. ..	Brassicaceae ..	Oct.-Dec.
Cajanus cajan (L.) Mil. ..	Papilionaceae ..	Jan.-Feb.
Carthamus tinctorius L. ..	Asteraceae ..	Jan.-Feb.
Celosia argentea L. ..	Amaranthaceae	Mar.-Sept.
Coriandrum sativum L. ..	Apiaceae ..	Sept.-Oct.
Cosmos lupinatus Cav. ..	Asteraceae ..	Jan.-Oct.
Crocus sativus L. ..	Iridaceae ..	Oct.-Nov.
Cucumis sativa ..	Cucurbitaceae ..	
Fagopyrum eculantum Moench. ..	Polygonaceae ..	October
Faeniculum vulgare Mill. ..	Apiaceae ..	
Gossypium spp. ..	Malvaceae ..	Mar.-Dec.
Guizotia abyssinica Cass. ..	Asteraceae ..	October
Helianthus annuus L. ..	Asteraceae ..	Jan.-Oct.
H. dubius L. ..	..	Sept.-Oct.
Impatiens balsamina L. and other spp.	Balsaminaceae ..	Oct.-Nov.
Ipomea learii Roxb. ..	Convolulaceae ..	Oct.-Nov.
Linum usitatissimum L. ..	Linaceae ..	February
Musa paradisica L. ..	Musaceae ..	Jan.-Dec.
Origanum vulgare L. ..	Lamiaceae ..	Oct.-Nov.
Papaver spp. ..	Papaveraceae ..	Feb.-Nov.
Pennisetum typhoides (Burn.) Stapf. and Hubb. ..	Poaceae ..	July-Dec.
Phlox drummondii Hk. f. ..	Polymoniaceae ..	Feb.-Dec.
Portulaca grandiflora Hr. ..	Portulacaceae ..	June-Oct.

Besides these, the following wild and cultivated plants serve as a source of nectar :

Atalantia racemosa Lamk.
Barleria sp.
Various lilies
Palms particularly *Cocos*, *Areca*, *Borassus* and *Sabal.*
Roses
Hissopus and members of Labiateae
Vitex negundo Linn.
T. erminalia bellirica (Gaertn.) Roxb.
T. arjuna t. and Arn.
T. chebula, Rotz.
Tecomela undulata (Smith) Spach.
Zizyphus jujuba
Z. mauritiana Lamk.
Bauhinia racemosa Lamk.

C. PLANTS OF SPECIAL HABITATS AND HABITS

11. Drought Resistant Plants in Deccan

In the years 1917-18 there was no rain at all in Ahmednagar district and in parts of Marathwada. This resulted in complete drought and famine in this area. As a consequence of it all the wells, rivers, canals dried up. Water at the surface and underground got completely evaporated. Soil developed large cracks in the sticky black cotton soil. Inspite of this, some drought resisting plants did survive and sprouted after scanty rains that came in the third year. These plants were studied by Shri R. K. Bhide 1921, *J. Ind. Bot. Soc.* 26 and *27* : 27-43, and listed with their xeromorphic peculiarities. Similar conditions are also often noticeable in the desert plants of Rajasthan.

Drought resistance in plants develops physiological mechanism C4 to C3 mode of photosynthesis. A critical examination of these plants has shown that many of them have C3 mechanism. C4 plants in the area are very few. Prof. G. V. Joshi has scanned the list given below to know which of these belong to C3 and which to C4. Some apparently behave like succulents changing their photosynthetic mechanism from C3 to C4. The development of the drought resistance is generated in them by the physiological conditions like those in mangroves and succulents.

The abovementioned drought in Bombay Deccan lasted over 1917 to 1919. It was very severe and long. Usually the normal rainfall over most of the area of Bombay Deccan is 15 to 30 inches per annum. But in those years, it was actually 1/3rd to 1/2. In 1918 wild plants in monsoon did not grow well. Even the most resistant plants like *Acacia arabica, Ficus bengalensis* and *Opuntia nigricans* got dried up.

Shri Bhide tried to ascertain what plants actually remained alive next year after such a long drought and what amount of moisture was available to their root system and general behaviour of these plants and their adaptations.

It was found that there was only 3-3.5 per cent moisture in soil around the roots of some dried plants. Their size and number were reduced. Plants with prostrate habit reduced their leaves and branches e.g., *Polygonum plebejum, Chrozophora prostrata, Solanum xanthocarpum, Argemone mexicana* dried completely. On the other hand, *Euphorbia neriifolia, Salmalia malabarica, Opuntia nigricans, Gymnosporia rothiana, Fluggea leucopyron, Lantana camara, Vitis woodrowii, Acacia arabica,* shed their leaves completely. Plants at Belapur had dried roots but not entirely. Newasa, Shevgaon, Pathardi, Ahmednagar had still lower water content in the soil around the roots of plants, only 0.80 to 3.93 percent. Some developed leafy bracts, rough hairs, short woody roots hardly 1 to 2 inches long e.g.. *Leptadenia prostrata* which normally has 10 inches long roots. The shape of leaf in many of them was changed in *Lepidagathis trinervis, Tephrosia purpurea, Cocculus villosus, Morinda tinctoria,* and in many others. Very few grasses survived. But in them, *Andropogon* developed tufted perennial fibrous roots.

Even trees like *Feronia elephantum, Ailanthus excelsa, Butea monosperma, Tamariandus indica, Ehretia aspera, Vitex negundo, Ficus retusa, Phoenix sylvestris* had parched leaves. Some became leafless e.g., the shrubs of *Capparis divaricata. Rhus mysorensis,* climbers like *Vitis pallida, Rivea hypoercrateriformis, Tribulus terestris.* They

practically were leafless. Only the underground parts of *Ischaemum pilosum, Andropogon pertusa , A. annulatas, Cynodon dactyoln* remained. During the hottest part of the year, the amount of moisture became so less that it was only 1.4-2 per cent in clayey soils. In gravely soils and in deep black cotton soil it was 3-4 per cent. A general reduction in the size of aerial parts of plants, leaves and branches, was there. Tap roots in all these plants were highly characteristic. They had strong, woody underground system which enabled them to survive under these extreme xeric conditions. The small xerophytic shrubs and herbs did not regenerate. The worst had happened in Maharashtra during the Durgadevi famine.

Maharashtra as a whole is semi-arid region, barring Konkan and parts adjacent to Sahyadris. Therefore, any failure of rains or shortfall, creates conditions of aridity such as those described by Bhide. Drought resisting plants and dry deciduous forests only survive, and have been in existence in Maharashtra since the sub-recent period, probably earlier upto Miocene at least.

List of drought resisting plants is given below.

Drought resisting plants in the Deccan

Species	Photosynthetic mechanism*
Polygonum plebejum R. Br.	C3
Chrozophora prostrata Dalz.	C3
Solanum xanthocarpum Schl.	C3
Argemone mexicana L.	C3
Euphorbia neriifolia L.	C3
Bombay malabaricum DC.	**
Opuntia nigricans Haw.	C3
Gymnosporia rothiana Laws.	..
Fluggea leucopyrus Willd.	..
Lantana indica Roxb.	..
Vitis woodrowii Stapf.	C3
Acacia arabica Willd.	C3
Lepidagathis trinervis Nees	C3
Tephrosia purpurea Pers.s	C3
Zizyphus xylopyra Willd.	C3
Tragia cannabina L.:	..
Echinops echinatus Roxb.	..
Leptadennia reticulata W. and A.	..
Cucumis trigonus Roxb.	C3
Tridax procumbens L.	..
Vernonia cinerea Lam.	..
Cocculus villosus DC.	..
Morinda tinctorea Roxb.	..
Heliotropium supinum L.	..
Alysicarpus rugosus DC.	C3
Trichodesma indicum R. Br.	C3
Celosia argentea L.	C3

*I owe this information to Dr. G. V. Joshi of Shivaji University of Kolhapur who expired recently.

** not available.

Species	Photosynthetic mechanism
Heliotropium zeylanicum Lam.	C4
Taverniera nummularia DC.	..
Citrullus colocynthus Schrad.	C3
Balanites roxburghii Plauch.	..
Trianthema pentandra L.	..
Boerhaavia diffusa L.	C4
Dipcadi montanum Dalz.	C3
Cyathocline lyrata Cass.	..
Andropogon monticola Schultz	C4
Trees	
Feronia elephantum Cor.	C3
Ailanthus excelsa Roxb.	C3
Melia azadirachta L.	C3
Mangifera indica L.	C3
Butea monosperma (Lam.) Taub.	C3
Cassia fistula L.	C3
Tamarindus indica L.	C3
Parkinsonia aculeata L.	C3
Acacia arabica Willd.	C3
Prosopis spicigera L.	C3
Diospyros memellanoxylon Roxb.	C3
Salvadora oleoides Dcne.	C4
Ehretia aspera Roxb.	..
Vitex negundo L.	C3
Euphorbia tirucalli L.	C3
Bridelia retusa Spr.	..
Ficus bengalensis L.	C3
F. retusa L.	C3
Phoenix sylvestris Roxb.	..
Shrubs	
Capparis aphylla Roth	C3
C. divaricata Lam.	C3
Cadaba indica Lam.	C3
Gymnosporia rothiana Laws	C3
Rhus mysorensis Heyne	C3
Cassia auriculata L.	C3
Mimosa hamata Willd.	C3
Dichrostachys cinerea W. and A.	C3
Opuntia nigricans Haw.	CAM
Calotropis procera R. Br.	C3
Jatropha curcas L.	..
Fluggea leucopyris Dalz.	..
Agave vivipara Wight	CAM
Climbing shrubs	
Vitis pallida W. and A.	C3
Gymnema sylvestre R. Br.	C3
Cryptostegia grandiflora R. Br.	C3
Rivea hypocrateriformis Choisy	C4

Species Herbaceous plants	Photosynthetic mechanism
Cleome viscosa L.	C
Polygala erioptera DC.	..
Triumfetta rotundifolia Lam.	C3
Tribulus terrestris L.	C4
Indigofera cordifolia Heyne	C3
Corchorus antichorus Raens	C3
Blumea malcolmii HK.	...
Vicoa auriculata Cass.	...
Flaveria contrayerba Pers.	..
Evolvulus alsinoides L.	C4
Lippia nodiflora Mich.	C3
Achyranthus aspera L.	C4
Aerua javanica Juss.	C3
Aristolochia bracteata Retz.	..
Grasses	
Pennisetum alopecuros Nees.	C4
Ischaemum pilossus Hock.	C4
Andropogon pertusus Willd.	C4
Andropogon annulatus Forsk.	C4
Cynodon dactylon Pers.	C4

12. SUCCULENT PLANTS

These are found growing in xeric conditions. They are characterised by their fleshy nature either of leaves, stems or of both. Generally they have spines as defensive structures. Many of them are found in the desert regions of the world *e.g.*, Cacti. Maharashtra though not a desert, is considered semi-arid in many parts. The succulents and drought resistant plants that grow there are not all true xerophytes ; they only wear xerophytic mask and show xeromorphic features. It is difficult to draw a line between semi-desert and arid desert xeromorphic plants.

It is believed that all desert plants have water saving and storing devices such as reduction of leaf surface to reduce transpiration, sunken stomata, water storage tissue, thick cuticle or epidermis multiple hypodermis etc. Some desert plants and succulents have water absorbing and storing roots, contractile roots, tuberous roots and stem. Deep laid roots, superficial fibrous roots, deep set large tap root ; and above all effecient photosynthetic mechanism. Their epidermis and cuticle is often covered with wax and profuse hairs. Many of them have Crassulean photosynthetic cycle and some have CAM system. All these adaptations make them efficient for surviving in hot desert regions. They have elaborate arrangements for food storage.

There are two types of succulents : those with leaves and those without leaves. Some of them are physical xerophytes and some physiological xerophytes e.g., Mangroves are considered to be physiological xerophytes. Cacti are true xerophytes. On the top of Himalayas there are fleshy plants which also suffer from physiological inability to have water due to formation of ice crystals in their tissues. They become succulent. They have thick cuticle and profuse hairs developed during winter.

As a rule xerophytes—true or apparent—have large tap roots deep below the soil or sand. There is good Cactus section in Lal Bagh Garden, Bangalore; National Botanical Garden, Lucknow; and at the Late Maharaja's Palace at Saitala near Ratlam :—

List of important Succulent Plants in Maharashtra with fleshy leaves on stem

Portulaca species
Vitis quadrangularis Wall.
V. setosa Wall.
V. longata Wall.
Bryophyllum laciniosa Naud.
Kalanchoe bhidei Cooke
K. floribunda W. and A.
K. glandulosa Hochst.
K. laciniata DC.
K. spathulata DC.
Begonia concanensis DC.
B. crenata Dryand
B. malabarica Roxb.
B. minima Bedd.
B. roxburghii DC.
B. trichocarpa Dalz.
Trianthema monogyna L.
Anotis quadrilocularis Hk. f.
Notonia grandiflora DC.
Caesulia axillaris Roxb.
Periploca aphylla Dcne.
Sarcostemma brevistigma Wt.
S. *stocksii* Hk. f.
Tylophora tenuis Bl.
Hoya carnosa Br.
Ceropegia acuminata Grah.
C. angustifolia Dalz.
C. attenuata Hk.
C. bulbosa Roxb.
Frerea indica Dalz.
Caralluma fimbriata Wall.
C. edulis Bth.
Salvadora persica L.
S. oleoides Dcne.
Heliotropium indicum L.
Ipomoea biloba Forsk.
Herpestis monniera H. B. and K.
Limnophylla concerta Bth.
L. gratissima
L. heterophylla Woodr.
L. polystachya Bth.
Leptadenia spartinum Wt.
Clerodendron inerme Gaertn.
Piper longum L.
Peperomia pellucida H. B. and *K.*
P. portulacoides Dalz.
P. wightiana Miq.
Cassytha filiformis L
Loranthus wallichianus Schultes
L. scurrula Linn.

L. gibbosus Talbot.
L. cuneatus Heyne.
L. longiflorus Desrouss.
L. lageniferus Wight
Viscum orientale Willd.
V. angulatum Heyne.
V. articulatum Burm.
Euphorbia acaulis Roxb.
E. antiquorum L.
E. clarkeana Hk.
E. coccinea Roth.
E. crithroclada Boiss.
E. glauca Roxb.
E. granulata Forsk.
E. heterophylla L.
E. ligularia Roxb.
E. microphylla Heyne.
E. neriifolia Dalz.
E. nivulia B. Ham.
E. parviflora L.
E. prostrata Grah.
E. pulcherrima Willd.
E. rosea Retz
E. rothiana Spr.
E. splendens Boj.
E. tirucalli L.
E. tithymaloides L.
E. uniflora Dalz.
Pilea microphylla Liebm.
Habenaria affinis Don.
H. candida Dalz.
H. commelinifolia Wall.
H. crassifolia Rich.
H. digitata Lindl.
H. diphylla Dalz.
H. foliosa Rich.
H. gibsoni Hk.
H. gigantea Don.
H. laciniata Dalz.
H. lawii Hk.
H. longecalcarata Rich.
H. marginata Coleb.
H. modesta Dalz.
H. platyphylla Spr.
H. rariflora Rich.
H. rotundifolia Lindl.
H. schizochilus Grah.
H. stocksii Hk.
H. uniflora Dalz.
H. viridiflora Br.
H. wightii Trim.
Agave americana L.
A. cantala Roxb.
A. rigida var. *sisalana* Woodr.
A. vivipara
A. vera-cruz Mill.
Dipiadi concanense Dalz.
D. minor Hk. f.

D. montanum Dalz.
Pedalium murex L.
Cleome aspera Koen.
C. cheliidonii L. f.
C. monophylla L.
C. vahliana Fees.
Capparis aphylla Roth.
Flacourtia latifolia Cooke
Leea macrophylla Roxb.
Sansevieria cylindriea Boj.
S. variagata

13. Aquatic Angiosperms and Pteridophytes

Some angiosperms and Pteridophytes grow in water. They form roots in the substrate mud and throw up their leaves, flowers and fruits or sporophylls, spore producing parts, spores on the surface of water *e.g.*, *Nymphaea alba.*, *Limnanthemum indicum* (now recognised as *L. numphoides*). *Equisetum* etc. Some others remain always submerged and their flowers come to the surface of water only at the time of fertilization *e.g.*, *Vallisneria*, *Blyxa*, *Lageresiphon*, and again they go back and live below water. Still others grow only at the subsurface of the water but do not root in the substrata *e. g. Lemna, Wolffia, Pistia.* The fourth category is of those whose spores and seeds germinate in mud, and plants that sprout grow in shallow water. Others grow at the margin of the pond. They live partly as aquatic plants for some time and later lead a terrestrial life, *e.g.*, in *Isoetes* some species are fully submerged and some half-submerged and some terrestrial.

An aquatic plant is one which needs presence of water to grow and to complete its life cycle. It must have some part of its life cycle in water or with its help.

Most of the water plants are very well adapted to aquatic existence. They have stomata on the upper surface of leaf while some have none. The exact number of aquatic plants is not known. They have been described by various workers (Agharkar, 1923 ; Biswas and Calder, 1953 ; Mirashi, 1954-1975 ; K. Subramanyam, 1962). Subramanyam has described 117 taxa of aquatic angiosperms spread over 32 families. In Maharashtra a large number of them occur in lakes at Umred, Khandala, Katyani Rankala and Kagal near Kolhapur, and also in isolated lakes at high altitude at hill stations like Panchgani, Mahabaleshwar and Khindsi (Ramtek).

Many water plants are common all over India due to their specific similar requirements, except the members of the Podostemaceae growing in fast moving streams at high altitude places like Khandala or Mahabaleshwar in Western Ghats and at Cherrapunji in Meghalaya. The representative of Pteridophytes are *Equisetum*, *Isoetes* and species of water ferns like *Marsilea*, *Azolla*, *Salvinia* (which is not found in Maharashtra), and *Ceratopteris thalictroides*. The last fern may occur as a floating aquatic or may grow on wet mud at the lake margin. Similarly *Acrostichum aureum* may grow amphibiously or in brackish marine water at Goa.

The late Prof. M. V. Mirashi has described physiological anatomy of a number of water plants around Nagpur and his work is considered important, particularly on Cyperaceae, Compositae etc. Some water plants were earlier described by Prof. J. F. R. D'Almeida also.

The list given below excludes marine water plants like *Enhalus* or *Halophila* since they are grouped with plants in mangrove swamps. They have been treated elsewhere. The list below does not claim to be exhaustive :

List of Common Aquatic Angiosperms in Maharashtra

[After Cooke (1908), K. Subramanyam (1962-1978), Nagendran, Blasco (1971), and others]

	Flowering period
Ranunculaceae :	
Ranunculus aquatilis	
Ranunculus seperatus	
Nymphaeaceae :	
Nymphaea stellata Willd.	Throughout year
Nymphaea nouchali Burm.	Throughout year
Euryale ferox Salisb.	Cultivated
Nelumbo nucifera Gaertn.	Before and after rains
Cruciferae :	
Nasturtium officinale R. Br.	
Elatinaceae :	
Elatine triandra Schk.	July
Bergia capensis L.	Sept-Jan.
Balsaminaceae :	
Hydrocera triflora (L.) Wt. and Arn.	
Leguminosae :	
Papilionoideae :	
Aeschynomene indica L.	Throughout year
Aeschynomene aspera L.	In winter
Mimosoideae :	
Neptunia oleracea Lour.	Monsoon and winter
Haloragaceae :	
Myriophyllum tuberculatum Roxb. *Myriophyllum spathulatum* Blatt. and Hallb.	Throughout year at Khandala, Mahabaleshwar.
Myriophyllum spicatum L.	
Myriophyllum intermedium DC.	Jun-Dec.
Myriophyllum indicum Willd.	Throughout year
Myriophyllum verticillatum L.	Jun-Aug.
Callitrichaceae :	
Callitriche stagnalis Scop.	Feb.
Onagraceae :	
Jussiaea repens L.	Oct-Jun
J. suffruticosa	Sept-May
Ludwigia parviflora	
Trapaceae :	
Trapa bispinosa Roxb.	Rainy season
Gentianaceae :	
Nymphoides cristatum (Roxb.) O. Kuntze.	
Nymphoides indicum (L.) O. Kuntze.	Nov-Mar.
Nymphoides aurantiacum (Dalz). O. Kuntze.	Nov-Dec.

Numphoides parvifolium (Griseb). O. Kuntze.	Nov-Dec.
Hydrophyllaceae :	
Hydrolea zeylanica	
Convolvulaceae :	
Ipomoea aquatica Forsk.	Nov.-Mar.
Scrophulariaceae :	
Limnophila rugosa (Roth) Merrill.	Sept.-Oct.
Limnophila aromatica (Lamk.) Merrill.	Jun.-Jan.
Limnophila heterophylla Benth.	Sept.-Dec.
Limnophila aquatica (Willd.) Santapau.	Dec.-Mar.
Limnophila indica (L.) Druce	Rainy and cold seasons
Dopatrium junceum (Roxb.) Buch-Ham.	Rainy and cold seasons
Dopatrium lobelioides (Retz.) Benth.	Sept.-Jan.
Lentibulariaceae :	
Utricularia stellaris L.	Rainy season
Utricularia flexuosa Vahl.	Oct.-Feb.
Utricularia exoleta R. Br.	
canthaceae :	
Cardanthera difformis Druce.	
Asteracantha longifolia (L.) Nees.	Oct.-Feb.
Amaranthaceae :	
Alternanthera sessilis (L.) DC.	Throughout year
Polygonaceae	
Polygonum orientale L.	Rainy season
Polygonium pulchrum Bl.	
Polygonum glabrum Willd.	
Polygonum barbatum L.	
Podostemaceae :	
Indotristicha ramosissima (Wt.)	
Terniola zeylanica (Gardn.) Tul.	
Terniola zeylanica Tul. var. *konkanica* (Willis) Santapau	
Dicraea dichotoma Tul.	
Dicraea stylosa Wt.	
Hydrobryopsis sessile (Willis) Engl.	
Griffithella hookeriana (Tul.) Warm.	
Willisia selaginoides (Bedd.) Warm.	
Farmeria indica Willis	
Zeylanidium olivaceum (Gardn.) Engl.	
Zeylanidium johnsonii (Wt.) Engl.	
Zeylanidium lichenoides (kurz.) Engl.	Jan.-Feb.
Zeylanidium lichenoides (Kurz.) Engl. var. *khandalense* (Willis) Santapau	
Zeylanidium lichenoides (Kurz.) Engl. var. *bhorense* (Willis) Santapau	
Podostemon subulatus Gardn.	
Podostemon barberi Willis	
Ceratophyllaceae :	
Ceratophyllum demersum L.	Jan.-Mar.
Hydrocharitaceae :	
Hydrilla verticillata (L. f.) Royle	Oct.-Jan.
Nechmandra alternifolia (Roxb.) Thw.	Oct.-Feb.
Vallisneria spiralis L.	Oct.-Mar.
Blyxa auberti Rich.	Dec.-Jan.

Blyxa echinosperma (Clarke) Hook. .. Dec.-Feb.
Blyxa octandra (Roxb.) Planch. .. Dec.-Jan.
Hydrocharis dubia (Bl.) Blacker. .. Nov.-Dec.
Ottelia alismoides (L.) Pers.
Halophila ovalis (R. Br.) Hook. .. Sept.-Oct.
Enhalus acoroides (L. f.) Rich.
Lageresiphon Roxburghi Benth.

Pontederiaceae :
Monochoria hastata (L.) Solms in DC. Rainy season
Monochoria vaginalis (Brum. f.) Presl.
Eichornia crassipes (Mart.) Solms in DC.

Typhaceae :
Typha angustata Bory and Chaub.

Araceae :
Pistia stratiotes L. .. .. .. Hot season
Cryptocoryne retrospiralis Fisch.

Lemnaceae :
Spirodela polyrhiza (L.) Schleid. .. Feb.-Apr.
Lemna paucicostata Hegelm. .. .. May-Jan.
Wolffia arhiza (L.) Wimm. .. .. Jun.-Oct.

Alismataceae :
Caldesia parnassifolia Parl. .. .. May-Sept.
Caldesia oligococca Buchen. .. .. Jun.-Oct.
Limnophyton obtusifolium (L.) Miq. .. Apr.-Aug.
Sagittaria sagittifolia L. .. .. .. Feb.-May
Sagittaria guayanensis H. B. K. .. .. Aug.-Nov.
ssp. *lappula* Bogin.

Butomaceae :
Tenggocharis latifolia (D. Don) Buchen. Nov.-Mar.

Aponogetonaceae :
Aponogeton natans (L.) Engl. and Krause Throughout year
Aponogeton crispum Thunb. .. .. July-Dec.
Potamogeton nodosus Poir. .. .. Jan.-July
Potamogeton octandrus Poir. .. .. Throughout year
Potamogeton perfoliatus L. .. .. Throughout year
Potamogeton pectinatus L. .. .. Throughout year
Ruppia maritima L. .. .. .. Jan.-May
Zannichellia palustris L. .. .. .. Feb.-June
Cymodocea rotundata Aschers and Schw.
Cymodocea (R. Br.) Aschers.
Cymodocea isoetifolia Aschers.
Diplanthera uninervis (Forsk.) Aschers.

Najadaceae :
Najas graminea Del. .. .. .. Mar.-Sept.
Najas graminea Del. var. *minor*
Najas indica (Willd) Cham.
Najas minor (Pers.) All .. .. .. All seasons
Najas minor All. var. *spinosa* Rendle
Najas lacerata Rendle
Najas faciculata A. Br.

Eriocaulaceae :
Eriocaulon rivularis.
Eriocaulon setaceum L. .. .. .. Aug.-Sept.
and other species.

Xyridaceae :
Xyris indica L.

Cyperaceae :

Cyperus cephalotes Vahl.	May-Jan.
Cyperus platystylis R. Br.	May-Jan.
Cyperus articulatus L.	Throughout year
Cyperus corymbosus Rottb.	Throughout year
Scirpus grossus L.	Aug -Dec.
Scirpus articulatus L.	Jan.-May
Scirpus kysoor	

Besides these species of *Kyllinga*, *Eleocharis* occur in some ponds.

Gramineae :

Coix aguatica Roxb.	Sept.-Nov.
Paspalidium geminatum (Forsk) Stabf.	Throughout year
Pseudoraphis spinescens (R. Br.) Vickery	Throughout year
Leersia hexandra Sw.	Throughout year
Hygroryza aristata (Retz.) Nees ..	Oct.-Apr.

N. B.—This list excludes plants of salt marshes such as *Sueda maritima, Orthoenemum indicum, Salicornia, Artiplex* species (see also list of mangroves.)

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14. ISLANDS IN THE ARABIAN SEA AND THEIR FLORA.

There are more than 100 islands in Arabian sea all along the West Coast of India, lying at variable distance from it. They are of different size and are important from the view points of defence, oil and gas resources, commerce and sea traffic. They occur in two subgroups on Maharashtra coast. Important of them are as below :—

(*A*) *Bombay sub-group*—consisting of 7 islands.

(*B*) *Malvan sub-group*—6 islands.

(*A*) *The Bombay sub-group* (18°.55′ N, 72°.54′E.)–

1. Elephanta Island or Gharapuri [famous for c
2. Butcher's Island
3. Armoury Island
4. Nhava Island
5. Manori Island
6. Sheva Island
7. Madh Island

(*B*) *Malvan sub-group* (16°.3'N, 73°.28'E)—

8. Kawade Bakal
9. Devatara
10. Padamgad
11. Sindhudurg
12. Vengurla Oyster Rocks
13. Redi Fort.

Of these, the plants of Elephanta Island have been recently surveyed by Dr. A. G. Untawale of the National Oceanographic Institute, Goa. Plants of Madh Island have been collected by Dr. G. G. Shah and recently by Untawale. The latter botanist has also surveyed islands in the Arabian sea along the coast of Gujarat, Saurashtra, Goa and Malabar.

The flora of these islands is in no way different from that on the main land of Maharashtra facing them. It is in no way insular. The flora is of the monsoon dry or moist deciduous type. They are fringed or encircled by mangrove vegetation which is the same as on the west coast of India, in sticky mud flats all around. They appear to have arisen in not very distant past and have similar flora as on the mainland opposite them.

15. Flora of Mountain Tops, Ghats and Endemics

Throughout Western India, there are small passes or *ghats* going down from heights of Sahyadris to Konkan. They are also present on the Desh side starting from hill tops to plains down below *e.g.*, Kannad ghat near Aurangabad going to Ajantha and Chalisgaon, or Melghat in Amaravati district, Nandurbar ghat going down to Surat from Amalner. There is continuous erosion of the mountain slopes and top flats. On account of this there is hardly any soil, 2″-3″ on top of the mountains, and the plants growing there are very much stunted trees, bushes, a few herbs and grass. But on the middle slopes of ghats, in valleys and ravines at lower levels, there is good vegetation. Vegetation on the top contains a few trees of *Tectona grandis*, at places *Bridelia retusa*, *Ailanthus excelsa*, *Hydnocarpus wightiana*, *Terminalia* species, *Memecylon umbellata*, *Syzygium cumini*, *Atlantia racemosa*, *Sterculia guttata* depending upon the altitude, rainfall and situation. Here one notices *Leea macrocarphyla*, *Gymnosporia montana*. If the rain is more *Lagerstroemea lanceolata*, if less *Flacourtia ramontia*, are seen. On several hill tops at the highest level, one sees in the crevices of rocks *Begonia*, *Delphinium*, *senecio*, *Smithia* species and some temperate herbs. Since the dry season here lasts for 7-8 months species like *Elaeocarpus* are found only on the

lower slopes. Mostly there are deciduous species as they withstand the drought period well *e.g., Terminalia tomentosa, Anogeissus latifolia.* On the lower-most slopes and in ravines small leaved evergreen species are seen *e.g., Garcinia indica* or *Macaranga peltata.*

The climate of Maharashtra and Deccan in general is dominated by the SW monsoons and dry continental winds in winter. In summer, it is hot and dry. The rainfall for the last 100 years at least has not shown any trend to increase or decrease than what it is at present. However, there seems to have had changes during *Miocene-Pleistocene,* in arid Miocene, and in cold Pleistocene periods, but these changes hardly affected radically the stratigraphy, geomorphology or the pattern of vegetation. It has remained nearly similar through Quaternary. Of course there were some short or long spells of humid climate and equally drastic spells of arid climate. This resulted in some species getting extinct, others migrating from their original locations to other areas. Some disappeared altogether from Maharashtra and Deccan *e.g., Enigmocarpon* and *Nypa.*

Recently Dr. R. S. Rao (1978) has studied the flora and floristic patterns along the lengthwise axis of Sahyadris at several places from Surgana bordering on South Gujarat to Agumbe in Coorg in Karnatak. He has given a full account of trees, bushes and shrubs at different places and altitude in the western ghats. It was noticed that more humid species like *Litsea, Hopea, Dipterocarpus* from Malabar flora come upto Amboli ghat *via* Goa, but they completely disappear from Sahyadri ranges further north ; on the other hand, dry deciduous species from the North Sahyadris increase in number in Sindhudurg district. Paradoxically enough, as Rao has pointed out, side by side with heavy rainfall areas having evergreen or semi-evergreen forests in the lap of Sahyadris, there are also arid zones to the east of Sahyadris on Desh side where sparse deciduous forests, scrub or open grasslands occur. This contrast is explained on the basis of climate, rainfall, lack of humidity and soil in those regions, nature of soil and ratio of drought period to humid period. But even then this cannot be explained only on the basis of climate, rainfall or soil. In Assam also a similar situation exists where *Dipterocarps* both living and fossil occur on poor soil. This has much to do therefore, not only with climate and soil, but also with the past history of the flora and vegetation in those regions.

From the heights of high ranges of Sahyadris down to plains we get almost vertical sections of the Sahyadri ranges and vegetation at several places, from 1400 m high, down to plains 30 or 50 m. As we go down the ghats, or climb them up, change in the vegetation becomes apparent. At the highest level there are either depauperated deciduous forests, grass and discontinuous pockets of tropical semi-evergreen species on the Desh side at different levels in valleys, and in Mavals, in the vegetation of Dev Raies. The vegetation in high rainfall areas essentially consists of small leaved evergreen or semi-evergreen species e.g., *Cinnamomum tamala, Garcinia indica, Actinodaphne hookeri, Litsea serrulata* etc. But more interesting vegetation is seen in the middle of the ghats which is a conservatory of various groups of plants that come down from top levels e.g., *Syzygium cumuni, Symplocos beddomei, Terminalia chebula,* of some rare and endemic plants, fungi, liverworts, mosses and ferns. On the lowest level there is a zone of bushes consisting of strands of gregarious *Nilgirianthes reticulatus, Carvia callosa, Barleria involucrata, Carrisa congesta, Holarrhena antidysenterica, Calycopteris floribunda* etc.

But there are also large areas in the Sahyadris where only grass, a few shrubs and spiny trees like *Xeromphis spinosa* or *Euphorbia neriifolia* and some woody climbers grow. Although this is paradoxical the situation seems to have arisen due to historical changes in terrain, in addition to changes due to climate and soil erosion.

Dr. R. S. Rao (1978) has shown that there is variation in vegetation from Surgana to Coorg ghat and in species as one goes from north to south correlated with climate. There are evergreen forest trees under humid conditions in North Kanara, Mercara and further down in Malabar. Deciduous type of vegetation is seen throughout on the slopes of Sahyadris (300-800 m altitude). Tall evergreen forests occur in Shimoga and Coorg (700 and 900 m altitude). On the higher slopes and tops of Sahyadris (800-1500 m altitude) only stunted trees, scrub, and sparse pockets of semi-evergreen forests are seen. From Phonda-Amboli further south semi-evergreen vegetation gives way to tall semi-evergreen or evergreen forests in Agumbe and Mercara ghats. They are full of tall tropical trees and also the Sholas. Due to semi-arid climate throughout Maharashtra and low humidity, the canopy of tropical trees, even in Mahabaleshwar ghats, is not much impressive being formed by *Syzygium, Calophyllum, Canarium, Mammea.* These plants begin to appear from Phonda-Amboli ghat, Goa ghats and Braganza ghats. They become denser in ghats of Karnatak. The rainfall in Western ghats being for a short period, the vegetation even of evergreen forests is not so thick as in the forests of Eastern ghats where rainfall and humidity are better distributed throughout the year, and last for a much longer period. In the Western ghats total rainfall is more but the leaching of soil is also more. According to Lagris and Meher Homji (1973), it is not only the total amount of precipitation but also the relative proportion of dry drought period to moist season is important for vegetation, because long dry period affects vegetation considerably.

Rao (1978) has enlisted typical species found in each of the ghats from Dangs to Mercara, on the lower and upper slopes of Sahyadri ranges in different ghats from north to south and has noted the floristic-patterns of vegetation. Broad-leaved species occur in abundance in Karnatak ghat forests. They are mixed with small leaved tropical species in Goa and Sindhudurg. Dry deciduous species occur mostly in northern Sahyadri ghats beyond Sawantwadi.

He has also pointed out that there are more than 100 endemic species in western ghats. Prominent among them are *Frerea indica, Senecio hewrensis, Iphigenia stellata, Dicanthium panchganiense, D, mccannii, Pancratium santamariae, Arisaema caudatum, Bhidea burnsiana, Belosynapsis kewensis, Euphorbia erythroclada, Habenaria* sp. Presence of endemic plants gives character to the flora of places.

16. MONSOON EPHEMERAL FLORA

The greater part of Maharashtra depends on South-West monsoons for rains, barring a few places like Bhandara, Chandrapur etc. in Vidarbha. The monsoons being a periodical phenomenon the flora also responds to them by producing plants and flushes of flowers periodically. A very remarkable flora of this nature appears more on the hill tops during mid-monsoon months. It springs suddenly, completes its life cycle, disperses seeds and disappears. It is extremely spectacular after the mid-monsoon months. The tuberous Liliaceae Scitamineae, terrestrial orchids, Compositae, Commelinaceae spring up suddenly and also the

colourful Leguminosae like *Smithia* species. About 225 such ephemeral plants are known and many of them have already been described in various chapters before. The whole list therefore is not repeated here. Monsoon Ephemeral flora is a special remarkable feature of the mountain flora of Maharashtra.

17. Dev Raies or Sacred Groves

All along the Western Ghats there are small enclaves of semi-evergreen trees or groves of a few evergreen plants around the temple of a local deity. Under the fear of deity people are forbidden to cut any tree or shrub or grass there. The groves thereby get preserved and plants conserved. Attention to them was first drawn by Dr. D. D. Kosambi in 1962, who noticed that vegetation in the Dev Raies is different from that in the surrounding areas. They contain many tropical species like *Holigarna grahami*, *Syzygium cumini*, *Ficus racemosa*, *Terminalia crenulata* etc. They are not to be seen in the vegetation around Dev Rai. The vegetation, like that of *Sholas* in Nilgiris, stands in strong contrast with that of the surrounding areas made up of deciduous trees, scrub or a few bushes and grass. Dev Raies also contain *Gnetum ula*, *Entada pursaetha*, *Salacia macrosperma*, *Hiptage madablota*, epiphytic ferns like *Leucostegis pulchra*, *Psilotum nudum*, *Lycopodium hamiltoni*, orchid species of *Dendrobium*, *Eria Oberonia*. Obviously they are the left overs from the vegetation of past ages and therefore are considered as relict.

There are about 250 Dev Raies in Western Ghats, and a few elsewhere in different parts of India. Gadgil and Vartak (1975, 1976) have studied them. Since these Dev Raies have ancient vegetation different from that in the present deciduous forest around, the question of their age needs consideration.

Some plants belonging to Palaeocene of Deccan and many of Neocene and some of later period given by Sahni, Uttam Prakash, Mrs. Chitaley, Lakhanpal, Ramanujam, R. Dayal, Biradar, Mahabale and S. V. Rao, Satyanarayan, Ingale, Bonde and others occur here. From that it is seen that some plants found in the Deccan Intertrappean flora of Nagpur-Chhindwada area are there. The temperate species are few, but species like *Pygium gardineri*, *Gmelina arborea*, *Leea macrophylla* seem to have continued. They are now common in semi-evergreen and deciduous forests of Deccan. The genus *Leea* has 6 or 7 species in different habitats. *Leea sambucina* is found in dense evergreen forests in North Kanara but other species, *Leea macrophylla* and *L. microphylla* are found in dry semi-arid regions of Deccan. *Leea sambucina* is not a woody species but the other two are woody species found in scrub or dry deciduous forests. Similar is the case of *Elaeoutia* species. This clearly shows that the vegetation in the past as of today had pockets of semi-evergreen vegetation, and that larger areas had dry deciduous forests, and semi-evergreen pockets. However the vegetation in the past must have been much richer than it is today. For example, *Tectona grandis*, *Adina cordifolia*, *Mitragyna parviflora* common in many parts of Deccan are not as tall or rich as in Alapalli forests in Chandrapur district. They form a very rich formation there. The average height of trees there is above 80—90′ and in some cases 141′ high. On the other hand in the semi-arid region elsewhere on Desh, and even on top of Sahyadris at Mahabaleshwar getting 250″ rain, they grow stunted, hardly 30—40′. They do not appear to belong to the same species. Probably the geomorphology, micro-climate sub-stratum, and ratio of dry to humid period

in a year appears to be the cause of it. The tropical species are seen on the middle slopes of Ghats where there is sufficient rainfall, sustained moisture and broad sunshine. Thus the tropical elements like *Hopea, Deptrocarpus, Holigarna, Hymenodictyon, Garcinia* species grow generally there in the middle of the Ghats above 2500-3000′. These plants appear to be relict species of past vegetation.

It is well-known that present position of Deccan had not been the same towards the end of Cretaceous and early Eocene or Palaeocene period. Palaeomagnetically it has been ascertained that it was at 7° in Southern tropics, but due to subsequent geological changes in tectonics, it moved about 15° N. Therefore the plants that we find in Dev Raies today are due to such distant historical changes, possibly in Neocene or Miocene when many plants migrated, some towards Nilgiris and some towards Kateru, Pungide and Rajamundry, and some towards Cuddalore.

The flora of Dev Raies is therefore considered to be due to successive historical changes and not due only to climatic changes.

We have already seen earlier the different plants that are found in different Dev Raies in Kolhapur district and those that occur in Savarde Rai. The vegetation and past history of all Dev Raies is worthy of detailed investigation.

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D. SOME NEWER DISCIPLINES IN BOTANY

Botany today has become many-sided, and some important developments have come into existence as aid to taxonomy or economic botany. But not much work has been done and hence we shall consider them briefly.

18. Aero-botany and Palynology : Its Application to Problems

This includes study of minute parts of plants such as pollen, spores, cuticles, bacterial and fungal spores floating in air. At about 300 above the ground they have been collected; beyond 500' to 1000' high up they are practically not there. The study of pollen grains and spores needs special methods to collect and to determine their intensity or numerical multitude. This is done with the help of Aero-palyrographs obtained on a clock-like rotating machine on which slides are fitted with a thin layer of vaseline to catch the spores and pollen floating in the air for 24 hours, and a record is kept. The importance of this lies not only in recognising botanically the plants to which they belong, but in the fact that some of them are capable of causing and spreading diseases. Some cause allergy, and therefore various aspects of this subject are being pursued vigorously by workers on air pollution.

The spores and pollen being single-celled organisms, very elaborate terminology has been evolved to describe them mainly by the efforts of the late Prof. Gunner Erdtmann of Sweden. He has decribed the morphology of spores and pollen and their relation to present taxonomy based on flowers and other parts of the plant. This is known as palyrology and its importance is growing mainly because it helps to distinguish such genera and species as could not be otherwise differentiated on the basis of gross taxonomy. It is, therefore, an important discipline among others to determine the systematic position of the genera, species and families. The spores and pollen, though are very small, they have their own morphological, physiological and chemical characteristics; for example, the pollen grains of various species of Compositeae and Acanthaceae. They are distinguished on the basis of pollen grain characters. Many fungal spores are distinguished by using Scanning Electron microscope.

But more than the mere descriptive palynology, its application to fossil spores and pollen is found in the coal bearing strata and in coal itself. It is of immense use to detect the kind of coal and stratigraphic position to the coal in different horizons. If a particular spore is having a distinctive character and is distributed in a particular layer in the strata, it is very helpful to find further coal or oil. The oil bearing strata and coal strata have their own flora of pollen and spores. Many of them are very small and are distinguished as belonging to a particular group of plants or species. But this is very often not possible and therefore, they are merely described as small spores, microspores or miospores, if they are less than 30um, and megaspores if more than 30 um. This classification worked fairly well because in recognising spores of the oil and coal bearing strata, it is not so important to know what exactly were their genera, but which is the index spore and whether it is available in 60 or more percentage. This method of using palynology in coal and oil exploration on the basis of spores is used the world over, including India. For example, the spore *Dandotiaspora* is common spore of Tura formation in Assam and is considered to be Index of the strata which is likely to yield oil. Similarly, the fossil spores of many coal

bearing strata of Gondwanas have also been scanned and their occurrence right from the very base of the Gondwana formation to the top most layer have been studied by the Lucknow School of Paleobotanists at the Birbal Sahni Institute of Paleobotany, Lucknow, and by the members of the Geological Survey of India, ONGC (Oil and Natural Gas Commission), Dehra Dun.

The fossil spores are generally described as "Sporae dispersae". In Maharashtra the work on the coal and oil palynology is being done by the professional experts of the Oil and Natural Gas Commission and by workers on coal mines. The findings of the former are not open to all and the latter only to a few. It is only now that the palynology of the coal bearing seams at Umred, Savner, Singareni and other places are being studied, by Dr. Shripad Agashe at Bangalore, etc.

Fairly advanced work is done on the other hand by applying this discipline to the problems of honey by Dr. G. B. Deodikar, Dr. Thakar, Shah, Salvi and Dr. Suryanarayana, Dr. Phadke and other members of the Central Bee Research Institute, Pune. This branch is called Mellito-palynology. It was known for a long time that the honey contains spores and pollen of unknown plants and gives colour or taste to honey; but the systematic efforts were done by the above institution only as early as 1954. Dr. Deodikar, Shri Thakar and Dr. Chaubal have described the pollen grains of major honey plants at Mahabaleshwar and have described them morphologically. They have also been able to recognise the pollen grains found in different honeys at Mahabaleshwar. The kind of honey is now recognized on the basis of the pollen grains found in it. They were so recognised before only in certain kinds of honey such as Rose honey, Lotus honey of Kashmir or Eucalyptus pollen in the honey of some foreign lands like Australia. At Mahabaleshwar they have been able to recognise honey from different apiaries, in different seasons, depending upon the outburst of pollen in the spring and in October seasons. Thus they recognise now the Karvi honey collected by the bees from Karvi plants *Carvia callosa, Strobilanthes* species, *Nilgirianthus* sp., *Randia* en Gela Honey from *R.dumetorum*, Jambhul Honey from *Syzygium cumini*, etc.

Disease forecasting :

Like temperature, rainfall, humidity and other climatic data collected and announced day to day and week to week by the Meteorological Department, in certain countries, they also announce palynological data. This is because certain pollen grains are supposed to cause asthma, skin diseases and so on. In Maharashtra State not much work has been done on this, which is necessary. Of late, a very pernicious weed from South America called *Parthenium hysterophorus* has come to India during war time, along with food grains. It has spread fast and wide in Maharashtra and other parts of India. All the open spaces are completely covered by it within a few years. It does not allow even grass to grow with it. The result is that many cultivable and open lands have been overgrown by it. No method of eradicating it so far has been found either by the use of chemicals, weedicides or biological control. It is believed that pollen grains of wild Solanaceae, *Casurina*, even *Eucalyptus* are prone to cause irritation, cold and lung diseases. Some people are allergic to pollen grains of a particular species. This was tested in a number of people. They were found to harbour pollen grains in their breathing track.

Dr. Mrs. Chitaley of Nagpur had made certain experiments to know upto what altitude the pollen grains are found, and what are the species of them. She found that many fungal spores of *Cladospora*, etc. are in air at high altitude. Prof. S. B. Mujumdar found them over sugarcane fields in Maharashtra.

Dr. S. T. Tilak has worked on the aero-flora of Aurangabad in which he found that the most prevalent spores at the end of rainy season and at the beginning of winter are the fungal spores of *Cladospora* , which are also found over the sugarcane fields in a number of places, besides yeast spores, and bacteria. It was also observed that the pollen of *Parthenium hysterophorus* was present in air all the time of the year except in summer. This shows the pernicious character of this weed. It induces allergy in some, the symptoms of which are similar to those of some insect bites. In other places the pollen was of *Argemone mexicana.* Pollen of certain Solanaceae and *Casuarina equisetifolia,* grasses is reported to be injurious to eyes. In the lung track of several people who suffered from asthma had more than 10-12 species of pollen grains and spores in their breathing track. This clearly shows how important it is to know the pollen and spores floating in the air over a place, particularly cities and industrial towns.

Dr. K. C. Mehta of Agra has found that rust disease of wheat in peninsular India is due to spread of uredospores of Wheat Rust on Barbery leaves growing in lower reaches of Himalayas, Terai, Nepal. From there they come to peninsular India and spread all over. There are no Barbery plants in the hills of South India ; Barbery is the alternate host of wheat rust. There is a Rust Research Station at Mahabaleshwar where all known physiological races of *Puccinia graminis*-the Wheat Rust, are maintained and rust resistance of wheat species and strains is determined.

The microspores or pollen of *Xanthium strumerium, Lantana camara Brassica nigra, Setaria intermedia, Moringa oleifera, Acacia nilotica Cassia siamea, Casuarina, equisetifolia,* of some grasses like *Cenerus* and others are often found floating in the air over the industrial cities like Calcutta. Extracts of pollens of these plants were made in glycerinated buffered solutions and after standardisation were tested by Dr. P. M. Wagle and Dr. S. H. Godbole of the Maharashtra Association for the Cultivation of Science, Pune. They were tested for allergenecity on a group of 75 suspected allergic persons, and on patients actually suffering from asthma and Rhinitis. The results showed that 1/3 of these patients were susceptible to allergy by pollen. Similarly spore extracts of *Helminthosporium, Aspergillus* (*A. fumigatus* and *A. niger*), *Trichothecium, Cladospora* and *Alternaria* species were tested subcutaneously. The test showed allergic symptoms in many (Wagle, P. M. in *Annual Report of the Maharashtra Association,* for cultivation of sciences 1977-78 : pp. 25-26). This shows that quite a number of individuals are susceptible to pollen or spore allergy. This is a branch of palynology which is of vital importance to man. Therefore, testing on a large scale for allergy is necessary in other cities as is done at the Sardar Patel Chest Research Institute, New Delhi.

Agriculture :

Aero-biology is a young science based largely on incidence of spores in air causing diseases in plants, men and animals. The most important of these pathogens are those which are suspended in air over crop fields. These are mostly Basidiomycetes lig. smuts and rusts. Other groups are

also represented, but these cause the largest damage to food crops, and therefore, tracing their incidence, time of dispersal and attack of disease are of considerable importance in Disease Forecasting Service. In India such studies are very few. There is no regular system of disease forecasting along with meteorological data. Work on this branch was started mainly due to efforts of the late Dr. Shriramalu of Andhra University and in Maharashtra by Dr. Tilak of Marathwada University, Aurangabad.

It has been observed that the maximum concentration of the spores in air, particularly the fungal spores, is at the surface of the soil, from where they spread elsewhere. In crop fields the optimum time of growth of a crop is important, because the spores attack the crop during that period, the damage is considerable. The various factors governing the dispersal of spores have been enumerated by Gregory, Tilak, Shriramalu and other workers on plant pathology. It has been found that fungal spores spread in large concentrations not during night but during the relatively drier period of the day between 9 a. m. and 2 p. m. Sometimes there are two peaks of the concentration of the fungal spores in air during a day. Different months have different fungal spores in the air. Generally, in the pre-monsoon period their concentrations are large, and they get dispersed on a larger scale. But during rains, and when the dew falls, their concentrations become less as they are precipitated on the soil or get inflated. The incidence of smut spores in relatively dry month of August in Kharif season is more and again in the months of December and January in Rabi season. Rust spores, on the other hand, are found in large concentrations during the months of Rabi season. Their periodicity, incidence and concentrations depend upon various factors such as microclimate, density of growth of the crop, temperature and initial concentration of the disease spreading. It is well known that uredospores come all the way from Himalayan reaches, Terai and Nepal and spread with monsoons all over the country spreading rust disease. The situation in various places varies and also the agricultural practices. There is no one month that could be said to have standard conditions. They are seldom available, and variants of them is a general rule.

Vertical profiles of palynograms reveal certain other facts made out by Dr. T. Shriramalu and his associates Subba Reddy and V. Ramakrishnan. Sugarcane is a major cash crop of Maharashtra and Andhra Pradesh. A definite correlation of the different spores with season is noticeable. Rust and smuts are generally spread from June to September and in pre-monsoon period. The control measures, therefore, will largely d pend on the detailed knowledge of the season in a particular year, coupled with meteorological data. But this is seldom done. The result is that the disease becomes known only after it has spread on a large scale. Sometime back there was incidence of *Phytopthora infestans* the well known Potato Blight disease at Panchgani. This was made known only when one of the workers in the Pathology Department of the Maharashtra Association, Pune, Dr. A. V. Sathe (1974) wrote about it. The Agriculture Department then started measures against it, but by that time major part of the crop was already damaged. Therefore, detailed and exact knowedge of the initial concentration of the pathogenic spores, their perio icity, the climate conditions, and knowledge of the local agricultural Practices are very essential for disease control.

As a matter of fact, the fungal and bacterial spores also cause diseases to plants from plants, to man and animals, A separate branch of this subject called Zoonosis has been developed. Shri Dev of Animal

Products Institute, Pune, has written a book in Marathi called "*janawaranche Rog, Wa Tyanche Aarogya*". It is interesting and helpful. It may be consulted.

19. LANDSCAPE GARDENING

Another branch in which very little progress has been made is the Landscape gardening. Floriculture is mainly concerned with ornamental plants. They are distributed by the various nurseries.

Landscape gardening, however, is only recently coming up as a subject along with Civil Engineering studies. In this branch the natural topography, trees in the surroundings and shrubs are so grown with cultivated ones as to merge together. The whole thing looks like a huge garden extended over a large area of landscape. Two best examples of Landscape Garden in the State are the Ganeshkhind Botanical Garden in the Poona University Campus where the landscape gardening was introduced by Sir Humphrey Repton in the year 1842, and a Forest Park and Botanical Garden at Hiwre started by Dr. Alexander Gibson in 1840. Another excellent example of the landscape garden in the country is the Government Botanical Garden at Ootacamund. Here the ornamental garden merges with the Natural Park, which in its turn merges with the forest in the background. The effect is that the whole hill looks as if it is a continuous planted garden. However, such attempts have not been made in Maharashtra State although the government have planned certain reserved areas for such developments.

The importance of landscape gardening lies in the improvement of the rural side and in planning of towns in urban areas. The landscape gardens afford a unique aesthetic pleasure to the citizens and hence most of the advanced countries have a large number of landscape gardens developed *e. g.* in Scotland, Holland, Southern France, Switzerland, Italy, Uzbeckistan, etc. where advantage is taken of the natural scenery, and the cultivated plants are grown according to a particular plan. They are also important for Plant Introduction.

In the whole world there are about 250 botanical gardens of different kinds. In our State there are six large parks. One is the famous Victoria Garden now called Jijamata Udyan at Bombay; the Hanging Garden on the Malabar Hill, Bombay; Empress Garden of Agrihorticultural Society at Pune; the erstwhile Ganeshkhind Botanical Garden at Ganeshkhind, Pune; Maharaj Baug at Nagpur and the old Mughal Garden at Khuldabad near Aurangabad.

20. ETHNOBOTANY

Plants enter into various activities of man and also afford him the food. In Maharashtra a lot of poor people live in hills and in the tracks which are not fertile. Their food requirements are not met ordinarily from the minor cereals and other poor food grain plants they grow. Maharashtra had been deficient in food production. It is estimated that about 2.5 million tonnes of food grains are required every month for Maharashtra from outside, besides the quantity that it itself produces. This is a rough estimate used by the government to import food from outside Maharashtra. Tribals like Bhils, Kolis, Katkaris and Dhodias have to supplement their food by using articles other than grains. Due to poverty they use many plants or their parts as supplement to their food. Most of these are tubers and underground parts which contain a

large amount of stored starch as food material , besides leaves of some wild plants. Such plants have been enlisted by Jain, Vartak and Datar (1975). They have studied the tuber crops and other materials used as food by poor people living in hills. A list of some of them is given below :—

Equally important is the problem of feed and fodder for cattle, because the grasslands dry up, and the forest trees shed their leaves in winter. There is no green fodder for the cattle. The cattle and sheep-keeping nomadic people migrate from drier areas to hills and to upland areas in search of some green grass, new foliage and edible plants. They feed on anything that is available.

A list of plants used as food by Adivasis (After Rekha Datar and V. D. Vartak, 1975)

(A) Tubers of the following are eaten after boiling :—

Amorphophallus campanulatus Beume
Arisaema murrayi Hook
Dioscorea alata Linn
Dioscorea oppositifolia Linn
D. bulbifera L.
Vigna capensis Walp.
Ensete superba Cheesemann (=*Musa superba*)

(B) Leaves, flowers and seeds of several fleshy plants are eaten.

(C) Fruits of several wild plants such as *Capparis zeylanica*, *Grewia abutifolia*, *Zizyphus* species, *Phoenix sylvestris* and *Ph. robusta*, *Syzygium cumini*, *Gmelina arborea*, *Ficus* species, *Emblica officinalis*, *Artocarpus heterophyllus*, *Carissa congesta*, *Cordia* spp., *Dillenia pentagyna*, *Diospyros melanoxylon*, *Moringa oleifera*.

(D) Leaves of the following are used :—

Murraya koenigii
Portulaca oleracea
Smilax zeylanica
Cassia tora
Leea macrophylla
Aroid-leaves and tubers eaten
Oxalis corniculata
Cordia dichotoma
Bambusa bambos
Moringa oleifera
Nymphaea pubescens
Phaseoelus radiatus

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21. Parks and Gardens

The utility of plants to man is not only for food, but also for aesthetic pleasure. For this purpose gardens, parks, reserved areas in forests are kept as Reservation Plots. Such national parks or gardens however are very limited in number and they all are not always open to public, because the effect of man has been found to be very destructive to such parks. People use them indiscriminately. Despite this, there is a National Park at Borivli; the well-known Tadoba Park in Chandrapur District; the famous Tiger Sanctuary in Melghat beyond Paratwada (Amravati district); Pratapsinh Park at Mahabaleshwar; Empress and Ganeshkhind Botanical Gardens, Pune, Maharaj Baug at Nagpur; Jijamata Udyan at Bombay; Hanging Garden at Bombay; and Karnala Bird Sanctuary are some of the famous parks in Maharashtra.

Floriculture :

Strangely enough more than half the flowers in towns like Pune or Bombay come from Bangalore, Dahanu, Devlali (Nasik) and other places, because there are very few regular large flower gardens. Only a few people grow them on a commercial scale, e.g. nurseries at Devlali near Nasik, Panchgani, Narayangaon, Sarola near Ahmednagar and a few other places. The tuberous flowering plants such as Gladioli, *Polyanthes* are widely cultivated near the large towns where they have a market. Roses are cultivated at Dahanu, Vasai, etc. Many of these are imported varieties. Due to the efforts of the Rose Societies and Agro-horticultural Society they are getting popular. In parts of Scotland, Southern France and in West Germany there are several beautiful gardens of roses and medicinal plants. At Chandigarh there is a 1000 acre Rose Garden. Cultivation of medicinal plants is not yet an industry, though they are required and used in many medicinal preparations according to Ayurvedic standards and prescriptions. Therefore Health Ministry of Govt. of India has started collecting and growing medicinal plants in gardens. One such garden in Maharashtra State is at Kothrud near Pune, known as Jawaharlal Nehru Ayurvedic Vanaspati Udyan. Here mostly the herbaceous and shrubby medicinal plants have been cultivated and others are being attempted; but the growth of drug yielding trees is slow, as they take time to grow to full stature to be a source of drug. The climate of Maharashtra and the varied structure of terrain from river bank, plains to high hills, cold and dry weather are extremely congenial for the growth of medicinal plants. But it is not yet thought to be industrially feasible by the people for want of knowledge and experience. The result is a number of pharmacies depend upon the local collectors who know where various medicinal plants grow wild. They collect them and sell to the pharmacies such as Zandu Pharmacy at Bombay, Dhutpapeshwar at Panvel, Pharmacy of Ayurved Seva Sangh at Nasik, Sandu Bros. Pharmacy at Chembur, APHALI at Ahmednagar, etc. Medicinal plants have been described by Agharkar.[1] It will be seen that more than 100 medicinal plants which are useful for several medicinal preparations are available in Maharashtra. But their systematic cultivation and exploitation is yet not practised. Many Ayurvedic physicians use substitutes for particular drugs, when the original drug yielding plant is not available. This was realised as early as 1840 by Dr. Gibson and he had started collecting and growing,

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[1] *Gazetteer of Bombay State, Botany (Revised Edition, 1953), Part-I Medicinal Plants.*

medicinal trees and plants in his famous garden at Hiwre (District Pune). The hills and the Ghat regions particularly are very suitable for the growth of medicinal plants and trees. Konkan (Sawantwadi) and Chandrapur areas are known for many medicinal plants. Cultivation of roses on industrial scales, as is done around Lucknow, Gaziabad, Kanoja, Bangalore is well worth expanding as a rural industry as CIBA are doing in Goa for some medicinal plants.

22. Bee Botany and other branches of taxonomy

A new development of Botany in Maharashtra is Bee Botany. It is mainly due to the work of Dr. G. B. Deodikar and his associates. Bees are good pollinaters and by putting hive lines in the crop fields or horticultural gardens, the yield is enhanced considerably, sometimes even 100 per cent. A large number of flowers do not form seeds because a particular pollinater is not present there. *Yucca gloriosa* plant and *Yucca moth* in Australia are classical examples of this. Application of this discipline in Agriculture and Horticulture is obvious.

There are three species of bees in Maharashtra. Rearing and keeping bees is a cottage industry in hilly parts. Besides these, there are two other branches of Botany *viz.*, Numerical Taxonomy and Chemostaxonomy. But there is no work on them in Maharashtra except two papers by Chandras (1968), and Chandras and Kelkar, Forest Ecology, Statistics. Plant introduction is also a neglected discipline in this State.

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E. FOSSIL PLANTS OF MAHARASHTRA AND FOSSIL FLORAS

23. Fossils and their kinds

Fossils are the remains of ancient plants and animals that lived in the past ages. They are preserved in the strata of rocks, but only in sedimentary rocks formed by continuous process of sedimentation. This requires aquatic and other suitable conditions for their formation, Therefore, fossils are not found everywhere. They are sometimes washed away from their original place and are re-deposited or scatterd elsewhere. Such conditions occur at the bottom of lakes, shallow seas, estuaries, river banks and similar places. It is possible with their help to determine heir age, and of the strata in which they are found.

In Maharashtra, the sedimentary rock system is known from two series, the Gondwanas and the Deccan Intertrappean Series. Besides these two, sometimes we get impressions on shales on the banks of rivers such as Pravara, Adhala, Godavari, Pranahita and Wardha. They be ong to different periods. The Gondwana system in Maharashtra is malinly exposed in the Wardha-Pranahita-Godavari valley and around Kamthi, Umred etc. The second system, the Deccan Intertrappean Series, occurs here and there over an area of 20,0000 sq. miles of Trap rocks spread from Bombay to the vicinity of Rajahmundry, from Satpuda mountains to Vikarabad, from Indore Sitapuri to Damoh, Goona, Sagar in Madhya Pradesh. The Gondwana rocks were formed under very special conditions in the valleys of Peninsular India where there were thick forests. They were sunk or covered later with ice sheets. Due to them a lot of coal has been formed in Bastar in Madhya Pradesh, in the valleys of Godavari, Pranahita, Wardha and Krishna rivers, in Talhir near Cuttack in Mahanadi and in Damodar Valley.

The Gondwana system is supposed to consist of Upper, Middle and Lower divisions. It began from the Upper Palaeozoic era and continued throughout the Mesozoic upto Lower or Middle Cretaceous period in Peninsular India. These deposits are rich in coal and are exposed at the fringe of Deccan Trap country. The Deccan Intertrappean beds also occur at the fringe of Deccan Trap Country. The Gondwana deposits are present also in extra peninsular India, but they are not fresh water deposits. Most of the coal deposits in Maharashtra, Madhya Pradesh and Orissa are fresh water deposits of the Gondwana period and are of great economic importance. They contain some of the best coal-bearing strata of India.

24. Fossiliferous Strata in Maharashtra : Their age as per International Geological Time Scale

The oldest age determination carried out for Indian rocks on the basis of radiometric measurements is about 3500 million years.

The entire time-span of the earth's history has been divided into four eras, *viz.*, Precambrian, Palaeozoic, Mesozoic and Cenozoic. During Precambrian era, the rocks formed in India are identified as Dharwar, Aravalli, Cuddappah, Delhi and Vindhyan Supergroups. They range in age from about 3500 m. y. to 600 m. y[1]. the beginning of the Palaeozoic era. The Palaeozoic era extends from 600 m. y. to 270 m. y. The major rock formations belonging to this era are coal-bearing Lower Gondwanas. In Maharashtra these rocks occur in Vidarbha. The Mesozoic era begins with Triassic period (225 m. y.) and ends with Cretaceous period (70 m. y.). The great volcanic activity commenced sometime in the Upper Cretaceous. A huge pile of basic rocks was formed due to successive eruptions of lava. The greater part of Maharashtra is occupied by these rocks. This activity continued during the early part of the Cenozoic era. The Cenozoic era started with Palaeocene epoch and continues to date. This era is divided into two divisions, the Tertiary and the Quaternary. The climatic fluctuations were experienced during Mio-Pliocene and also continued into Pleistocene. It shows alternation of glacial and interglacial climates. During Quaternary newer alluvium, delta deposits and blown sands etc. were formed. Similarly land has arisen which can be noticed from river terraces and raised beaches.

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1. M. Y.=million years.

GEOLOGICAL TIME SCALE

Era	Period	Systems Epochs or series	Fossiliferous Localities	Geochronologic age in million years	Total duration of the System (million years)	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Cenozoic .. (65 m. y.)	Quaternary	Recent ..	Travertine beds of Kotul in Ahmednagar district.	0.01	0.01	
		Sub-Recent	River valley leaf beds on Aluvium at Sangamner, Ahmednagar district.	..	..	
		Pleistocene ..	Leaf beds at Khandarmal	1·5	1	
	Tertiary ..	Pliocene ..	..	7	7	
		Miocene ..	Bombay-Worli and Bombay High, Bombay	26	17	Most of the oil in West coast at Ankaleshwar and Bombay High belongs to Miocene period.
		Oligocene ..		38	13	
		Holocene ..	Nagpur, Nawargaon and nearby localities in M.P. (Chhindwara, Sausar, Sagar).	54	27	Abundance of Angiosperms, dwindling of Gymnosperms.
		Palaeocene		65	10	
Mesozoic .. (180 m. y.)	Gondwana	Cretaceous	Upper Lower	140	75	Angiosperm including palms arose.
		Jurassic ..	..	200	60	
		Triassic ..	..	240	40	Most of the Coal resources are found in Gondwana period. Age of Gymnosperms.

GEOLOGICAL TIME SCALE—*contd.*

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Palaeozoic (370 m.y.)	Period	Permian	Chandrapur, Nagpur	290	50	
		Caboniferous	Upper Lower	350	60	
		Devoian	..	410	60	
		Silurian	..	544	35	
		Ordovician	..	505	60	
		Cambrian	..	605	100	
Proterozoic	..	Pre-cambrian	..	2,500	1,100	
Azoic	..	Archeans	..	3,600	..	

25. Gondwanas and their flora

The Gondwanas are divided into two divisions and according to others three divisions as mentioned above. Gondwana basin contains only a part in Maharashtra. Wardha, Pranahita and Godavari valley system forms a discontinuous chain of Gondwana rock exposures from Chandrapur to Rajahmundry. They also occur in small patches in Kaveri basin in Tamil Nadu.

We are mainly concerned with this system that occurs in Maharashtra. The distribution of Gondwanas in Deccan Trap Country is given elsewhere. Their several isolated localities occur in Deccan by which we mean the region which lies to the south of Narmada and to the north of Kaveri. The most important Gondwana areas in Maharashtra are those that occur in the Wardha-Pranahita-Godawari basin. They have flora comparable to that of Kota-Maleri or Rajmahals or Cutch. According to Wadia (1966), Lele (1973) and Surange (1964) they belong to Middle Gondwana (Triassic).

It is generally believed that in the early Gondwana period *Dicroidium* flora was abundant. Later it was succeeded by the *Ptilophyllum* flora in Upper Gondwanas. In between the *Neo-calamite, Schizoneura, Glossopteris, Dicroidium, Noeggerathiopsis, Gangamopteris* occur in Transitional Beds representing the Middle Gondwana flora. Each of these floras have their own peculiarities and constituents.

The Gondwana system contains the following seven stages :—

Lower Gondwanas :

Talchir stage in Maharashtra is found only on the banks of Wainganga river above its confluence with Wardha river 16 kilometres W-SW of Chandrapur. It is exposed fully in Madhya Pradesh in South Rewa basin in Johilla coal field. Fossil plants *Gangamopteris, Noeggerathiopsis*, seeds of *Cardaiocarpus* and *Samaropsis* are found in them.

Karharbari stage is not represented in Maharashtra but in Rewa in Madhya Pradesh. Its characteristic elements are *Buriadia* and *Gondwanidium*.

Barakar stage is well exposed in Bihar and has good coal. In Maharashtra it is exposed in small disconnected outcrops forming a chain from Chandrapur down to South, but they are not much known. They need to be studied.

Raniganj stage is exposed in different fascias in Maharashtra, principally in the coal fields of Kamathi, Koradi, Savner around Nagpur in ferruginous masses of sandstone. Kamathi stage is considered as equivalent to Raniganj of Upper Gondwanas. It is very well developed around Kamathi about 19·2 km. from Nagpur. In sandstones and argillaceous shales of Kamathi, fossil plants *Phyllotheca, Glossopteris, Gangamopteris hughesii, Vertebraria, Taeniopteris, Noeggerathiopsis, Neocalamites* are found.

Panchet or the last stage of the Lower Gondwanas occurs in Satpuda basin and at Mangli in Godavari valley. It contains *Glossopteris communis, Vertebraria indica* and *Dicroidium* sp. It is now believed to belong to the middle Gondwanas.

Kot-Maleri stage of Middle Gondwanas is developed in Godavari valley in the vicinity of Sironcha. *Glossopteris, Schizoneura, Neocalamites, Cladophlebis, Araucarites, Elatocladus* are found. They represent typical *Dicroidium* flora. It has logs of gymnosperms *Cupressionoxylon* and *Dadoxylon.*

Upper Gondwanas :

Rajmahal stage is practically absent in Maharashtra. It contains *Philophyllum, Taeniopteris, Araucarites, Williamsonia, Gleichenites, Ginkgoites* and others, constituting of *Glossopteris* flora. On the whole very little Gondwana flora occurs in Maharashtra. Only important sector of it occurs on the banks of Wainganga before its confluence with Godavari. In the Godavari valley *Ptilophyllum* flora definitely seems to have been succeeded by *Dicroidium* flora. Upper Gondwana flora is poorly represented down Sironcha, after the confluence of Pranahita with Godavari, upto Raghudevpuram (East Godavari district) and Rajahmundry. They offer an excellent field for research. Their resemblance with that in other parts in the country is yet to be decided. It is characterised by marine sequences and by the prevalence of *Ptilophyllum, Cycadophytes, Bennettitales, Williamsonia* and ferns like *Onichiopsis* or *Osmundites.*

By the time ice sheets receded the sea came up in the Wardha-Godavari valley. It again receded at a number of places and disturbed the glacial sediments. A special significance is attached to later Gondwana system, because of the Kamathi stage, near Nagpur. The Rev. Father Hislop first observed the *Glossopteris* leaf impression on the shales on the banks of river Kanhan here. When they were formed, the climate must have been very dry and desert-like. During the entire Triassic period (equated with Middle Gondwanas) the development of flora was discontinuous and occurs at distant places. Dinosaurs were rambling in Godavari valley from Paithan in Maharashtra to Maleri in Andhra Pradesh (Mahabale 1964). During this period the sea receded for a short time and came up again in Upper Gondwana period.

The middle Gondwana flora in Wardha-Godavari Valley has a large number of tree trunks of gymnosperms. Some of them are 2-3′ in diameter and are found at Aghari, Agarjhari in Chandrapur. *Dadoxylon, Plamoxylon, Kamthioxylon, Cupresinoxylon, Zenoxylon, Megaporoxylon* are found. Species of *Glossopteris gigas* occurs in large numbers. Most of them are anomalous gymnosperms. At Bazargaon and Satnauri near Nagpur, a *Scutum* type of *Glossopteris* fructification is found. *Schizoneura, Neocalamites* are also found in sandstone quarries there and occasionally *Vertebraria.* Thus typical Gondwana plants occur at various localities around Nagpur, Kamathi, Wardha, Warora, Aghari and Chandrapur. They suggest that although the Kamathi formation is often equated with Raniganj stage (Upper Gondwanas), it appears probably a little earlier than the Rajmahal or Jabalpur stage of the Upper Gondwanas. The phytogeography and ecology of this fossil flora in Maharashtra is not worked out. What is its relation to similar flora elsewhere is yet to be decided.

By the time Gondwana flora started dwindling the Deccan Traps began pouring out lava at the end of the Uppermost Cretaceous. The process gathered great momentum in Palaeocene and continued pouring out hot lava at various places throughout Maharashtra in Eocene period. The lava flows were poured out intermittently on varied surface. There are many important places for the collection of Gondwana and Tertiary

fossil plants. Literature on them is very vast as they are the earliest fossil floras known from India since the days of Feistmantel (1876-1882). Dr. Sheila Chandra and K. R. Surange's (1979) recently published extensive work on *Glossopteris Flora* of India be consulted with profit.

26. Tertiary Flora of Maharashtra : the Deccan Intertrappean Series

After the Glossopteris flora, the second important flora in Maharashtra is the Tertiary Flora of the Deccan Intertrappean Series related to Miocene or Neocene flora of Cuddore series in Tamil Nadu and to others elsewhere. The plants are preserved in the sedimentary rocks formed during the periods intervening between two volcanic outburst at a number of places in the Deccan Trap Country. The lava in the Deccan is supposed to have been poured out from long fissures which also got closed up later. They are seen now as many broad and long dikes and sills from where thin lava was supposed to have been poured out. It cooled and got consolidated. However, there are no cones or craters, usually found in the case of volcanic activity elsewhere. It is more like the type in Abyssinia, or like that in Idaho in America.

The rocks are amygdoidal and formed dark hard lava sheets, some grey and brittle. Sometimes the intervening period between two lava flows was long enough and allowed soil to be formed. On it the plants developed, and some new ones came up. They got embedded in the sedimentary deposits between two trap-layers known as Intertrappean beds. Admirably well preserved plants are found in them in cherts. It is known that silica is not soluble in water but Silicon trioxide in hot water is soluble to some extent. The flows were quite extensive, some times extending upto a furlong horizontally, but only a few feet in vertical height or thickness due to fluidity of the lava. The lava flows 3-12 poured outline parallel one above the other, often separated by thin layers of ash and look distinct and discontinuous. When the conditions became a little favourable, then the mud accumulated in intervening cavities during quiet period and allowed the plants to grow on them, only to be killed and preserved by the process of silicification. Even the most delicate plants like *Azolla* of flowers of *Sahnianthus*, *Sahnipushpum*, *Veeracarpon*, fungal hyphae and spores are preserved in the rotting tissues of wood fallen in lake waters ; or else they got charred. This gave rise to petrified plants in cherts in the Deccan Intertrappean Series. They are, however, not found in the Upper traps near Bombay but generally in the lower and middle traps at Nagpur-Chhindwada area and in Malwa.

Intertrappean beds of Eocene period occur at Takli, Navargaon, Bori, Bharatwada, Mahurzari and Kondhali, all near Nagpur. Other places are Sausar, Chhindwada, Mohgaon-Kalan, Mandla, Chari, Samnapur, Parapani in Madhya Pradesh adjacent to Nagpur. They are exposed above the marine Cretaceous Bagh beds at Deola Chirakhan, Sitapuri in Madhya Pradesh. There are no fossils, however, in the highest hills of Sahyadris in Western India like Khandala except at Worli or Dongri in Bombay. Throughout the Eocene Period the effusion of lava was very severe and intensive. It ended in Cretaceous in the Godavari Valley in Andhra Pradesh. The next outburst of lava was in Miocene Oligocene period. This was mostly in Andhra Pradesh at Kataru, Pangide, Rajahmundry ; and in Tamil Nadu in the Cuddalore series near Pondicherry. Their fossils are similar to plants today that occur in Maharashtra. Their preservation is not as good as it is in Chhindwada-Nagpur

area. They form the Cuddalore series and resemble with the modern species. Their fossils are intercalated with marine formations. Their structure is poorly preserved. In Tamil Nadu and at Neyveli, about 74 km. from Madras, huge lignitic deposits of the same age occur on a large scale, about 400 sq. km in extent. They provide fuel for the thermal electricity plant supplying energy to Madras. In Maharshtra no large scale lignitic deposits are known. It is known only in a well in the Theba Palace estate at Ratnagiri, Pavas and at a few other places.

There are well-known Miopliocene beds at places in Assam (Mizoram), called Tippam and Barails. They are also exposed in Himachal Pradesh at Jwalamukhi. But there is no comparison between the Early Eocene plants of the Deccan Intertrappeans with those in the strata at those places. The volcanic activity was also there at Anjar in Kutch and Saurashtra around Junagadh. They are, however, lithologically different, being some acid and some alkaline traps. We shall, therefore, mainly consider the Tertiary Flora of Maharashtra which belongs to the Early Eocene period, and make their brief comparison with those of the other areas.

Glossopteris flora of Mesozoic Gondwanas was followed by the Tertiary Deccan Intertrappeans and Quaternary Sub-recent Floras. Many of the Early Eocene Species are not there, but those in the Mio-pliocene Flora of Cuddalore Series are to be found in our present Peninsular Flora. Due to climatic fluctuations only a few have survived and that is why we get mixed species of different periods in our flora.

TABLE IX-E-26.1

Plant remains from the Deccan Intertrappean Series (Early Eocene) after Uttam Prakash, 1972

Family (1)	Fossil species (2)	Modern comparable form (3)	Locality (4)
Gymnospermae			
Coniferales			
Abitineae ..	1 *Industrobus bifidolepis* Sahni ..	..	Takli
	2 *Takliostrobus alatus* Sahni	..	Takli
	3 *Pityostrobus crassitesta* Sahni	..	Takli
Araucariaceae ..	4 *Mohogostrobus* Sahani Prakash ..	*Araucaria* ..	Mohgaon-Kalan
	5 *Dodoxylon deccani* Shukla	..	Chhindwada district.
	6 *D. resinosum* Shukla	..	Do.
	7 *D. eocenum* Chitaley	..	Chhindwada
	7a. *D. shuklai* Singhani	..	Chhindwada
Angiospermae			
Monogotyledons			
Musaceae ..	8 *Musa cardiosperma* Jain	*Musa* spp. ..	Mohgaon-Kalan
	9 *Musocaulon indicum* Jain	*Musa* or *Ensete*	Do.
Smilacea ..	10 *Smilacites mohgaoensis* Nambudiri	*Smilax aspera* ..	Mohgaon-Kalan

TABLE IX-E-26.1—*contd.*

Family	Fossil species	Modern comparable form	Locality
(1)	(2)	(3)	(4)
Zingiberaceae ..	11 *Amomocarpum sulcatum* Sahni	*Ellettaria* ..	Unknown
	12 *A. affine* Sahni ..	*Ellettaria cardamonum*	Unknown
Cyclanthaceae ..	13 *Cyclanthodendron sahnii* (Rode) Sahni	*Cyclanthus carludovica*	Mohgaon-Kalan
	14 Floral axis of Cyclanthaceae ..	..	Do.
Sparganiaceae ..	15 *Sparganium* Sp. Mahabale	*Sparganium* ..	Do.
Araceae ..	16 *Viracarpon hexaspermum* Sahni	..	Mohgaon-Kalan and Takli.
	17 *V. elongatum* Sahni Syr. *Shuklanthus superbum* Verma	..	Takli, Mohgaon-Kalan
	18 *V. tenue* Sahni ..	..	Unknown
	19 *Sahanipushpam shuklai* Verma	..	Mohgaon-Kalan and Mahurzari
Gramineae ..	20 Wood of Bamboo ..	..	Worli, Malabar hills, Bombay and Mohgaon-Kalan.
Cyperaceae ..	21 Stem and Flower of *Scripus*	*Scripus* ..	Worli and Malabar hills, Bombay
	22 *Cyperaceoxylon intertrappeum* Chitaley and Patel	..	Mohgaon-Kalan
Palmae ..	23 *Palmoxylon banfordi* Schenk	..	Near Zhansi on Narmada
	24 *P. libigianum* Schenk	..	Sitabardi
	25 *P. edwardsi* Sahni ..	..	Near Jabalpur
	26 *P. sagari* Sahni ..	..	Saugar
	27 *P. kamalam* Rode ..	..	Mohgaon-Kalan
	28 *P. hislopi* Rode ..	..	Mohgaon-Kalan
	29 *P. sclerodermum* Sahni	..	Seoni and Nawargaon
	30 *P.* (*Cocos*) *sundaram* Sahni	..	Saugar
	31 *P. sundaram* Sahni var. *vidarbhai* Rao and Menon		Mohgaon-Kalan
	32 *P. surangei* Lakhanpal	..	Kerala
	33 *Palmoxylon* sp. cf.	*Phoenix rupicola* and *Phoenix robusta* Mahabale	Mohgaon-Kalan
	34 *P. chhindwararence* Prakash	..	Mohgaon-Kalan
	35 *P. dakshaninense* Prakash	..	Mohgaon-Kalan

TABLE IX-E-26.1—*contd.*

Family	Fossil species	Modern comparable form	Locality
(1)	(2)	(3)	(4)
Palmae—*Cont.*	36 *P. eocenum* Prakash	..	Mahurzari
	37 *P. narayanai* Rao and Menon	..	Mohgaon-Kalan
	38 *P. mahabalei* Rao and Menon	..	Do.
	39 *P. parthsarathyi* Rao and Menon	..	Do.
	40 *P. maheshwarii* Rao and Menon	..	Do.
	41 *P. trabeculosum* Sahni	..	Saugar (Sagar)
	42 *P. fibrosum* Menon	..	Mohgaon-Kalan
	43 *P. deccanese* Sahni	..	Maragour
	44 *P. krishna* Sahni	..	Sitabaldi
	45 *P. scotti* Menon Dayal and Menon	..	Mohgaon-Kalan
	46 *P. pyriforme* Sahni	..	Sindhi Vihira
	47 *P. intratrappeum* Sahni		
	48 *P. krauselii* Rao and Menon	..	Mohgaon-Kalan
	49 *P. ravi* Menon ..	..	Do.
	50 *P. superabum* Trivedi and Verma	..	Kerla
	51 *P. cordatium* Trivedi and Surange	..	Mohgaon-Kalan
	52 *P. mohgaoensis* Trivedi and Surange	..	Do.
	53 *Palmocaulon mohagaoense* Deshpande	..	Do.
	54 *P. ravi* Menon ..	..	Do.
	55 *P. mahabalei* Menon	..	Do.
	56 *Rhizopalmoxylon Nipa*	..	Do.
	fruticans indicum Sahni	..	Do.
	57 *Palmostrobus* sp. Mahabale	..	Do.
	58 *Palmophyllum dakshinense* Achutan	..	Do.
	59 *Palmocarpon mohgaoense* Prakash	..	Do.
	60 *P. insigne* Mahabale	..	Do.
	61 *P. indicum* Prakash	..	Do.
	62 *P. sulcatum* Prakash		Do.
	63 *P. compressum* (Rode) Sahni	..	Do.
	64 *P (Iriarires) taklensis* (?)	..	Takli
	65 *Palmocarpon* sp. Sahni		
	66 *P. bracteanum*		
	67 *Nipa hindi* (Rode) Sahni	*Nipa fruticans*	
	68 *Nipadites* sp. Bowerbank		

TABLE IX-E-26.1—*contd.*

Family (1)	Fossil species (2)	Modern comparable form (3)	Locality (4)
Palmae—Contd.	69 *Nipa* sp. ..	*Nipa* ..	Mohgaon-Kalan
	70 *Tricoccites trigonum* Rode	..	Do.
	71 Fruiting axis of *Tricocates trigonum* Rode	..	Do.
(Dicotyledons) Flacourtiaceae ..	72 *Flacourtiates intertrappeum* Nambudiri	..	Do.
Malvaceae ..	73 *Hibiscoxylon intertrappeum* Trivedi and Ambawani	*Hibiscus* ..	Mahurzari
Tiliaceae ..	74 *Grewioxylon mahurzariense* Prakash and Dayal ..	*Grewia laevigata* ..	Do.
	75 *G. indicum* Prakash and Dayal	*G. tiliaefolia* ..	Do.
	76 *G. intertrappeum* Shallom	*Grewia* probably *G. laevigata*	Do.
Elaeocarpaceae	77 *Elaeocarpoxylon antiquum* Prakash and Dayal	*Elaeocarpus ferrungineus* ..	Do.
Simarubaceae ..	78 *Ailanthoxylon* Prakash	*Ailanthus malabarica*	Mohgaon-Kalan, Mahurzari and near Rewa.
	79 *A. ghierense* (Seksena) Prakash Verma and Dayal	*Ailanthus grandis* ..	Ghiar Rewa
	80 *Simarouboxylon indicum* Shallom	*Simarouba* Spp.	Mohgaon-Kalan
Burseraceae ..	81 *Boswellioxylon indicum* Dayal	*Boswellia serrata*	Keria
	82 Wood of Burseraceae	..	Mahurzari
Sapindaceae ..	83 *Sapindoxylon schleicheroides* Dayal	*Schleichra trijuga*	Keria
	84 *S. chhindwarensis* Chitaley and Shallon	..	Mohgaon-Kalan
Ampelidaceae ..	85 *Leeoxylon multiseriatum* Prakash and Dayal	*Leea* Spp. ..	Mahurzari
Anacardiaceae ..	86 *Anacardoxylon semecarpoides* Prakash and Dayal	*Semecarpus* Spp.	Do.
Leguminosae ..	87 *Aeschynomena tertiara* Prakash	*Aeschynomene* sp.	Do.
	88 Fruit of Hedysareae	..	Takli
	89 Fruit of *Cassia* ..	..	Do.
	90 Fruit of *Foboidea* Boweebank	..	Do.
	91 Fruit of Xulino *sprinites*	..	Do.
	92 Leaflets of *Acacia* ..	..	Worli and Malabar hills

TABLE IX-E-26.1—*contd.*

Family (1)	Fossil species (2)	Modern comparable form (3)	Locality (4)
Combretaceae ..	93 *Terminalioxylon tomentosum* Mahabale and Deshpande	*Terminalia tomentosa*	Ghala
Myrtaceae ..	94 *Dryoxylon mohgaoense* Rode	..	Mohgaon-Kalan
Lecythidaceae ..	95 *Barringtonixylon deccanense* Shallom	*Barringtonia acutangulata* ..	Mahurzari
	96 *B. eoptrocarpum* Prakash and Dayal	Barringtonia *acutangulata*	Do.
Lythraceae ..	97 Leaf of *Lagerstoremia*	*Lagerstoremia indica*	Mohgaon-Kalan and Bharatwada, Dedukur near Rajahmundry
Sonneratiaceae	98 *Sonneratixylon decurense* Krishna Rao and Ramanujam	*Sonneratia* Sp.	
	99 Wood of *Sonneratia*	*Sonneratia* Sp.	
	100 Wood of *Sonneratia* and *Duabanga*	*Duabanga* spp. and *Sonneratia* Spp.	Mohgaon-Kalan
	101 *Sahnianthus Parijai*	*Sonneratia acida*	Mohgaon-Kalan and Bharatwada
	102 *Enigmocarpon Paarijai*	*Sonneratia apetala*	
Euphorbiaceae ..	103 *Bridelioxylon krauselli* Prakash	*Bridelia* spp.	Keria
	104 *Mallotoxylon keriense* Lakhanpal and Dayal	*Mallotus philippinensis*	Do.
	105 *Paraphyllanthoxylon sahnii* Prakash	*Phyllanthoideae* group	Mahurzari
	106 *Paraphyllanthoxylon keriense* Dayal	*Briscofia*	Keria
	107 *Euphorbioxylon sagarense* Mahabale and Deshpande	*Bridelia* sp. ..	Saugar
Datiscaceae ..	108 *Tetrameleoxylon prenudiflora* Lakanpal and Verma ..	*Tetrameles nudiflora*	Mohgaon-Kalan
Guttiferae ..	109 Wood of Guttiferae	..	Mahurzari
Rutaceae ..	110 Wood of Rutaceae ..	..	Near Nagpur
Incertaesedis ..	111 *Aerorhizos harrisi* Chitaley	..	Mohgaon-Kalan
	112 *Dicotylirhizos sahnii* Rao	..	Do.
	113 *Phyllites mohgaoensis* Rode	..	Do.
	114 *Dicotylophyllum mohgaoensis* Nambudiri ..	..	Do.
	115 *D. intertrappeum* Nambudiri	..	Do.
	116 *Indocarpa intertrappeum* Nambudiri	..	Do.
	117 *Carpolithus striatlus* Jain and Dayal	..	Do.

Distribution of the modern compa·able species of fossil taxa from the Cuddalore series (Age-Mid-Miocene), after Prakash 1973. *Geophytology* 2 (2) : 179. with living once.

TABLE IX-E-26.2

Past Fossil species	Modern Comparable species	Present Distribution
1. *Mesuoxylon arcotense*	*Mesua ferrea** ..	Evergreen forests of Western Duras, Assam, Mizoram, Nagaland, Arunachal, Chittagong, Upper Burma, Tenassarium, Andaman Islands, Western Ghats of North Kanara Southwards to Tinnevelly.
2. *Calophylloxylon indicum*	*Calophyllum wightianum*	Evergreen forests of Western Ghats, North Kanara to Kerala.
3. *C. cuddalorense* ..	*Calophyllum tomentosum* and *C. inophyllum**	Evergreen forests of Western Ghats from North Kanara to Kerala, West coast, Orissa, Andamans, Burma, found along coasts above high water mark and in mangroves.
4. *Glutonylon* ..	*Gluta travancorica* .. and *G. melanorrhoea*	Evergreen forests of South Kerala South-east Asia.
5. *Mangiferoxylon scleroticum*	*Mangifera altissima* ..	Malaya in evergreen forests.
6. *Ebenoxylon arcotenses*	*Diospyros assimilis* ..	Evergreen forests of north Tamil Nadu, Western Ghats, South Kanara to Kerala, from 1200-4000 altitude.
7. *Cynometroxylon dakshinense*	*Cynometra travancorica*	Evergreen forests of South Kerala and near Tinnevelly.
8. *Tamarindoxylon antiquam*	*Tamarindus indica** ..	Evergreen tree diffused throughout India and in tropics generally.
9. *Peltophorxylon variegatum*	*Cassia fistula** ..	Indus to Arunachal in the east, in South Gujarat, Madhya Pradesh, Maharashtra, Deccan Karnatak, east and west coast and further to Sri Lanka. Usually a deciduous tree ascending to 4000 ft. in Himalayas.
10. *Putranjivoxylon puratanum*	*Putranjiva roxburghii** ..	Evergreen tree found along river banks throughout semi-tropical India.
11. *Ailanthoxylon indicum*	*Ailanthus malabarica* ..	Western Ghats and South Kanara
12. *Shoreoxylon krauseli*	*Shorea talura* .. and *Shorea tumbuggaia*	Evergreen or moist deciduous forests of West Coast, Coorg, Tamil Nadu, Malabar, Mysore, North Arcot Cuddalore, Andhra Pradesh.
13. *Dryobalanoxylon*	*Dryobalanops, oblongifolia*	Sumatra, Borneo and Malayan *Peninsula.*
14. *Barringtonioxylon*	*Barringtonia** ..	Coast of Tenassarium Tree with evergreen leaves, South Konkan.
15. *Careyoxylon pondicherriense*	*Careya arborea** ..	Throughout India in moist forests, also in Tamil Nadu and Kerala.

* Species marked do exist in Maharashtra.

TABLE No. IX-E-26·2.—*contd.*

Past Fossil species	Modern Comparable species	Present Distribution
16. *Sonneratioxylon preapetala*	*Sonneratia apetala** ..	Littoral species of evergreen trees or shrubs of the Coromandel coast, Bombay etc.
17. *Parinarioxylon cuddalorense*	*Parinarium corymbosum*	Malaysia
18. *Alangioxylon scalariforme*	*Alangium javanicum and A. meyeri A. lamarkii**	Malaysia, Belgaum hills.
19. *Anogeissusoxylon indicum*	*Anogeissus latifolia* ..	Throughout the dry forests in India from north to south ; in Tamil Nadu, Eastern Coorg and Shimoga districts in Karnatak, South Kerala.

*Species marked do exist in Maharashtra.

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27. Quaternary Flora of Maharashtra

The first part of the Cenozoic era is Tertiary, and it lasted for about 60-70 million years. Of these, Palaeocene lasted 10 million years and Neocene 40 million years i. e. Miocene Oligocene, Pleiocene together occupied 40 million years. The second part of the Cenozoic era is the Quaternary period. The Pleistocene is the first part of it. It lasted for about one million years, followed by Sub-Recent and Recent which lasted for about 12,000 years, and then came the pre-historic period. Sub-Recent and Recent were short periods compared to Eocene or Mio-Pleistocene periods.

Tertiary flora of the Deccan Intertrappean Series belongs to Pleiocene. The Mio-Pleiocene flora lying above it is seen in Cuddalore Series in Tamil Nadu and in Tippam Series in Mizoram, but are not in Maharashtra. Miocene was essentially a hot dry period and long. It was succeeded by the moist, cold or arid cold climate of the Pleistocene. Climate changed several times. There were 3 or 4 glaciation periods. There is not much record of the Pleistocene flora in Maharashtra. However the Pleistocene period gave rise to old and new river alluvium. Below the new alluvium of rivers like Pravara, Adhala, Godavari and Wardha, there are calcarious shales impressed with leaves, but not as large deposits. The lateritic and regur soils are supposed to have been formed continuously, even at higher altitudes, by the process of sub-aerial action, and leaching of soils. They are all unfossiliferous. But in Sub-Recent times, in the vicinity of Sangamner below the river alluvium some leaf impressions are found at several places on calcarious shales.

There are also large tuffaceous deposits at Kotul on the banks of Mula river, and traverine caves. They were studied by Dr. D. R. Mahajan (1978) for fossil plants. He noted some flowering plants at Khanderaowadi, Mojalwadi, Nandur-Khandarmal etc. all in the vicinity of Sangamner in Ahmednagar district, and even a little peat at one place.

Plants found in travertine deposits at Kotul are mostly blue-green algae and diatoms. They are more like the present ones in fresh water. One Calcarious moss was also found. The fossil leaf shales at Sangamner on the bank of Pravara river, are overlain by archaeological deposits at Jorwe, Newasa and other places.

The list of plants seen on calcarious shales has among others *Ficus arnottiana*. This *Ficus* today grows in heavy rainfall regions like the ghats of Sahyadris. But at Khanderaowadi its fossil impressions are found deep in the lowest strata. A small lens-shaped cavity is also there. It is full of peat, about 150′ long and 2″ in vertical height. It seems a local development in a water trench or pot-hole. The peat contains pollen grains of some water plants and of *Salix* and *Podocarpus* *Salix* and *Podocarpus* do not grow here. *Podocarpus* has migrated south upto Tinevelly. *Salix* is still present on the river banks in stray strands at high altitude of Sahyadris. Other plants are *Odina woodier* and a *Bambusa* species. They occur in low dry hills and slopes. The former is a member of deciduous forests, and bamboos are found wild in moist or dry deciduous forests. Possibly in the Sub-Recent time they might have been growing under similar conditions, but due to progressive dessication of Deccan later, they started dwindling and disappeared.

The tuffaceous flora at Kotul has some fresh water Cyanophyceae, Diatomaceae, besides a Pottiaceous moss, *Anoectangium strecheyaum* Mitt. This tuffaceous bed appears to be later than the leaf-beds at

Sangamner. The leaf-bed is a continuous deposit after Pleistocene period, as it lies deep below the soil surface but above the heat pocket at the bottom of a local ditch.

The Quaternary Sub-Recent flora thus presents no different picture than that of the present day flora; only the species appear to have migrated or differently distributed. By further redistribution, and addition of new species from the surrounding regions, the present day flora of Maharashtra seems to have been formed.

In this connection, it is necessary to note that after the Quaternary Sub-Recent flora, not many changes have taken place in the geomorphology, geography and vegetation pattern in Deccan peninsula. India assumed its more or less present day form and position. after the late Miocene. Only a few changes took place in Maharashtra in Pleistocene. But in extra-Peninsular India tremendous changes took place due to tectonics and desiccation towards the end of Miocene period, such as rise of the Himalayas, changes in the river drainage systems, changes in the rain shade rainfall pattern, drying of Tethys, change in altitudes of mountains in North India etc. Rajasthan desert was formed filling the Indo-Ganga plain and the Rann of Kutch. Glaciation was also there. These are important events that markedly affected the plant, animal and human life in India. Man appeared on the scene in Pleiocene period after Miocene.

In Maharashtra tropical plants lingered in semi-evergreen pockets, and others migrated towards South India. The temperate species migrated to high altitude in Sahyadris, Baba Budhangiri and Nilgiris, and got locked up there. Many species disappeared from ghats and Desh due to uncertainty of rainfall and rise in temperature. The evolution of forests in Deccan was probably as suggested below by Mahabale (1978):—

(1) Evergreen-semi-evergreen-Moist deciduous-dry deciduous-thorn savannah-scrub-open grasslands in areas with less rainfall, poor soil or murum, or as a result of large drought period, mostly on the Desh side. Dr. Meher Homji (1976-78) of the French Institute, Pondicherry agrees with this view and has rightly pointed out that deciduous forests when degenerate due to paucity of soil, rain, humidity, adverse ratio of humid to dry period, ultimately develop into scrub on the Desh side. On the other hand when there is more rain and low temperature they again develop into moist deciduous forests or semi-evergreen forest. The past history of plants in Maharashtra thus, throws a good deal of light on various problems connected with the plant life and vegetation pattern in Maharashtra. The presence of open grasslands on the slopes of Sahyadris with pockets of relict evergreen or semi-evergreen forest is explicable on the above considerations. For example, in Miocene period onwards in the flora of Peninsular India, the genus *Shorea* was abundant, which was not so before. But subsequently *Shorea robusta* lost ground and *Tectona grandis* came forward as main component in the dry deciduous forests all over the Deccan Plateau.

There are other problems too, connected with the evolution and geographical distribution of certain genera in our flora. They can only be understood by looking to their past history and present day distribution, *e.g.*, genus *Terminalia*. This genus has about 23 species in Indian flora, of which 13 species occur in Maharashtra and 6-7 in Madhya Pradesh *Terminalia tomentosa* is one of them. It was growing right

from Eocene times till today having the same anatomical structure of xylem in living as well as fossil specimens. It has not undergone any change obviously. It is a highly conservative species. Some other are lingering in Dev Raies and Ghats *eg*., *Conarium* and Musa superba in Ghats. But many have migrated to Cuddalore area in South India. Several genera of Maharashtra flora are found in fossil flora of Cuddalore (See lists below).

28. QUATERNARY TRAVERTINE FLORA OF KOTUL

[After Dr. T. S. Mahabale and D. R. Mahajan 1972, Geophytology, **2** (**2**) : 175-177, and D. R. Mahajan 1976, *Journ. Poona Univ*. Sci. and Tech. **48** : 32-42.]

Angiosperm Leaf impressions found near Sangamner (Dist. Ahmednagar).

1. *Ficus glomerata* Roxb :

Locality—Khanderaowadi. Leaf bed on the bank of Pravara river below alluvium 19 km to the East of Sangamner (Dist. Ahmednagar), Age-Sub-Recent.

2. *Ficus arnottiana* Mig :

Locality—Mojalwadi, 22.4 km East of Sangamner (District Ahmednagar).

Horizon and Age-Sub-Recent.

3. *Odina woodier* Roxb :

Locality—Mojalwadi, District Ahmednagar, in leaf bed-below, recent alluvium. Horizon-Late-Pleistocene; Age-Sub-Recent.

4. *Tectona grandis* Linn :

Locality—Nandur-Khandarmal (Ahmednagar) on the Pravara river bank below recent alluvium. Horizon-Late Pleistocene; Age-Sub-Recent.

5. *Diospyros melanoxylon* Linn :

Locality—Khanderaowadi (Ahmednagar) on the bank of Pravara river below alluvium. Horizon-Late Pleistocene; Age-Sub-Recent.

6. *Leea* Linn :

Locality—Nandur-Khandarmal (Ahmednagar), on the bank of Pravara river below alluvium. Horizon-Late Pleistocene; Age-Sub-Recent.

7. *Zizyphus jujuba* Lamk :

Locality—Khanderaowadi (Ahmednagar) below recent alluvium on Pravara river bank. Horizon-Late Pleistocene; Age-Sub-Recent.

8. *Bambusa arundinacea* Scherb :

Locality—Mojalwadi (Ahmednagar) in leaf-bed below recent alluvium on Pravara river bank.

Horizon—Late Pleistocene; Age-Sub-Recent.

9. *Bridelia hamiltoniana* Wall Cat :

Locality—Mojalwadi (Ahmednagar) on the bank of Pravara river below recent alluvium.

Horizon-Late Pleistocene; Age-Sub-Recent.

Travertine Algae and a moss in Travertine deposits at Kotul on Mula River bank, Dist. Ahmednagar [after Dr. D. R. Mahajan, 1978, Ph. D. thesis submitted to Poona University (unpublished).]

ALLGAE—

(*a*) Diatoms :

1. *Cyclotella bodanica* var. *stellata* Eulenstein.
2. *Stephanodiscus niagarae* Ehrenberg.
3. *Fragilaria pinnata* Ehrenberg.
4. *Cocconeis placentula* Ehrenberg.
5. *Navicula rhynococephala* Kuetzing.
6. *Pinnularia major* Smith.
7. *Gomphonema olivaceum* Kuetzing.
8. *Cymbella affinis* Kuetzing.
9. *Cymbella cistula* Grunow.
10. *Cymbella lanceolata* von Heurk.
11. *Ephithemis turgida* Kuetzing.
12. *Rhopalodia gibba* Mueller.
13. *Surirella elegans* Ehrenberg.
14. *Navicula oblonga* Kuetzing.

(*b*) Blue-Green Algae :

15. *Chroococcus macrococcus* Rabenh.
16. *Chroococcus rufescens* Nageli.
17. *Chroococcus turgidus* Nageli.
18. *Lyngbya contorta* Lemm.
19. *Schizothrix calcicola* Gomont.
20. *Scytonema ocellatum* Lyngbye.

(*c*) Moss :

1. *Anoectangium stracheyanum* Mitt.

All these algae are fresh water forms : the moss is a calcarious Pottiaceous moss.

F. EPILOGUE

With completion of the consideration of the Quaternary fossil plants at Sangamner and Kotul, and other floras such as Archaeological plants, we reach the threshold of prehistoric plants that existed there for thousands of years back. They contain cultivated plants such as *Hordeum vulgare,* (जव), wheat, bajri, rice and a few wild or little cultivated plants like *Zizyphus rugosa, Tamarindus Tindica,* etc. Mostly their hard parts like grains and seeds are found. But in the Archaeological sites in Maharashtra no pollen grains have been detected. However they give us some idea of the early agriculture, people, plants and animals in this part of the country, but not the complete picture. Passing from the Archaeological flora we come to the study of present day flora which is an outcome of the past flora modified by changes in the climate and other factors, and the new arrivals from the surrounding areas. Vegetation

at no stage remains unchanged; and therefore, even the present one we considered here will also alter in course of time. The procession of plant life in successive times goes on and on, and it is for the botanists to view and study it, and modify if possible by adding new plants for the use of man.

G. HISTORY OF PLANT STUDIES WITH SPECIAL REFERENCE TO MAHARASHTRA

The earliest history of plants of this region is seen in the plants that enter into the frescoes, sculpture and paintings in caves at Nasik, Ellora, Ajantha, Aurangabad, Karle, and Gharapuri near Bombay. There are also several references in Sanskrit *Puranas* to the thick forests and vegetation at Panchavati, Tryambak and other places in Maharashtra. In the Sanskrit dramas like *Uttarramacharitam* or *Mudrarakshas* there are also references to forests abounding then in Maharashtra. In Prakrit literature of Hemchandra, there is occasional mention of the vegetation at different places. All these and archaeological data give a faint picture of the then existing plants, the people and crops in ancient Maharashtra.

Garcia Da Orta (1490-1570):

Garcia Da Orta was a surgeon with the army of the Portuguese East India Company and his duties required him to travel from Colombo to Surat. For a number of years he was staying at Goa, and was a keen student of the plants of Western India. He was acquainted with the indigenous system of Ayurvedic medicine and even included some drugs like *Triphala* into his practice. He had collected a number of plants and trees from the Western Ghats and had planted them in a big garden around his residence. He died at Goa in 1570. His greatest contribution to Indian Botany is his work on "*Simple Drugs of India*" which attracted attention of European physicians and pharmacists, as it was the only new work after famous work *Materia Medica* of Discorides in 1st century A. D. Garcia's work was translated into Latin and in a number of other European languages and got spread all over Europe. However, the Inquisition, which was all powerful in those days, forbade its use and circulation, the book being on Indian drug plants. Only a few copies of it were printed at Goa and one of the copies slipped out of India and a missionary called Reclusius, translated its summary in Latin and other languages and got it published at Antwerp. This work became as famous as the work of Discorides (1st century) on the properties of medicinal plants.

Van Rheede and Hortus Indicus Malabaricus (1678-1703):

Another important work on the botany of Western India is the grand monumental treatise published by the Dutch Military Commandant of Malabar, Heinric Van Rheede. This was published in twelve folio volumes at Amsterdam. It is a very fine piece of work with beautiful illustrations of plants of Western India published by the authority of the Dutch Government. It was written by three Ayurvedic physicians by name Ranga Bhatt, Appu Bhatt and Vinayaka Pandit. The last one probably was a Maharashtrian settled in Cochin. They had taken oath in the name of their family God for writing truthfully, only what they knew authentically to be true about the properties of plants. This oath by Vinayaka Pandit is in Marathi. It is probably, as Prof. S. P. Agharkar pointed out, the first published script in Marathi. Throughout this work, the local Marathi, Konkani names, as well as names in

Tulu, Malayalam, Kannada, Tamil and Arabic languages are given for the plants. The illustrations and descriptions are good. Many of them formed the basis of names for Indian plants by Linneus in *Species Plantarum.* Some of these names have come down to us in binomial form after they were published in famous "*Hortus Indicus Malabaricus*" (1678-1703). No important work thereafter has come to light on plants of Western India till nineteenth century.

Earlier there was a tradition of Botany as a descriptive science, but it died in the dark ages, and no account of its achievements is available. However, it lingered on in the books of Ayurveda, specially in those devoted to the study of plants as sources of medicines, called *Nighantu.* Many of these suffer from the defect that too many names have been given for the same species, or the same name is applied to different plants. This tradition of *Nighantu* continued till the end of the 13th century. By that time some European adventurers and travellers had come to India, and they wrote on whatever plants they observed. Amongst these two important persons whose names must be mentioned are Munichi and Jacquemont. The account of the plants collected by Jacquemont who was a charming Frenchman is available. Earlier Bermier (1653-1667) had visited India during Jehangir's time (1605-1627) and wrote about the plants of Kashmir he had observed. However, so far as the Western India and Maharashtra are concerned, Jacquemont's collections are important. They are described in a work called "*Planteae Rariores Indiae Orientali Collectae A* Jacquemont" published by his friend Cambessedes in 1848. They are now in Paris.

By that time studies on plants of Western India were started in the Grant Medical College, Bombay. Professors of Pharmacology used also to teach Botany. Some were well-known *e.g.* Dymock (1832-1892), Sakharam Arjun (1839-1883), and Kirtikar (1849-1917), Lisboa. Dymock's work on the Bazaar Medicines of Bombay, Western India, is still a useful book for the use of plant drugs in Bombay.

These were succeeded by the formal study of plants by Graham, Dalzell, Gibson, Woodrow, Gammie and Cooke. A brief account of them is given by Puri (1959) in his account of the Western Circle of Botanical Survey, Poona (*Bull. Bot. Surv. India,* Vol. 1 (1) : 73-77). Similarly Pazi (1952) also has given an account of some of them in his paper on the Flora of Poona and neighbouring districts in *Poona Univ. Journal, Science section* 1 (2) : 1-52. Quite a number of these persons were civilians or men in the Forest, Medical or Revenue service or in Judiciary. For example, Birdwood was the Justice on the bench of High Court of Judicature at Bombay, Gibson was a Forester. Graham was Deputy Post Master at Bombay. However, the regular description of the plants of Western India was published by Dalzell and Gibson (1861) in their book "*Bombay Flora*". This was the first descriptive account of the plants of the then Bombay Presidency and was an improved version of the earlier list "*Catalogue of Plants of Bombay and Vicinity*" by John Graham (1839). Graham though a Deputy Post Master at Bombay used to make several trips to the Western Ghats and Khandala. The title of his book suggests that it is merely a list; it is not so. It gives a short account and sometimes diagnostic characters of the plants he had collected and described them. Unfortunately this extremely enthusiastic worker who must have visited Khandala Ghats several times even when there was no railway, died at a very young age of 34 at Khandala and lies buried in the cemetery very close to Saint Mary's Villa (now Police Training Headquarters), where his tomb is there. Locally it is

known as St. Xavier's Villa. G. M. Woodrow (1846-1911) was Professor of Botany at Science College at Pune and assistant to Dr. Cooke. He really built the herbarium of Western India. He published a paper (1895) on plants collected from Nagothana to Pune and other papers on Bombay flora in the Bombay Natural History Society's journal. In between a small book giving both popular and scientific description of plants of Western India was published in 1894 by the Rev. Nairne of the Bombay Civil Service (Ecclesiastical). He was stationed for a long time at Vengurla and Malvan ; naturally his book contains reference to a large number of plants in Konkan region. Similarly, Gibson during his service was stationed at several places and travelled a lot. He was the Chief Conservator of Forests. He collected on a large scale plants of North Kanara and Belgaum, followed by Talbot who was also the Conservator of Forests for Bombay and Sindh. Talbot wrote his famous book with excellent illustrations "*Trees, Shrubs and Climbers of Western India*" (1894). He also built large collections of plants from Sindh. All his collections are so beautifully mounted that even today they are a prized collection of plants of Western India in the herbarium of the Western Circle of the Botanical Survey of India at Pune. By far the most important book, *The Flora of the Presidency of Bombay* was written by Dr. Theodore Cooke, published after his retirement (1903-1908). He was the Principal of the then College of Science at Pune, now College of Engineering. His collections were taken to Kew from where he wrote at the instance of the Government of Bombay his well-known work "*Flora of the Presidency of Bombay*" between 1901 and 1908. The original set of plants including types at the Science College at Pune fell a prey to fire in that college, and was completely destroyed. However, Cooke had taken large collections with him to England from which, as he himself said, he had sent a complete set of plants (on which he wrote the three volumes of the said book) to the Science College for reference. This is now in the possession of the Western Circle of the Botanical Survey of India at Pune.

After these, studies on botany were vigorously carried out by different persons in the colleges where the studies on science were introduced after 1908. Members of the Jesuit Mission at Bombay, such as , Father Ethelbert Blatter, Hallberg, Caius, McCann all belonging to St. Xavier's College did marvellous work in Taxonomy, especially of Western India. Professor Hate of Wilson College, Dr. Kirtikar of the Indian Medical Service, Dr. Lisboa at Grant Medical College, not only made collections but also described them from time to time in the *Journal of the Bombay Natural History Society*. Kirtikar especially used to collect all kinds of plants and describe them. He was the first man to describe the fungi, liverworts and mosses of Bombay. Birdwood had collected plants of Matheran and Mahabaleshwar. Inspired by the tradition of these workers in Bombay a zealous worker of Junagarh, Jaykrishna Indraji Thakar described in Gujarati the complete Flora of Barda Dunger near Junagarh "*Barda Dungarni Vanaspati*" (1913) followed by another work "*Kachhani Vanaspati Ane eni Upayogita*" (Plants of Kutch and their uses). All these works are now a part of history and a great need is felt to bring them up-to-date both in point of collection and description.

A glance at the names of workers on the Botany of Western India including Maharashtra shows that it is really extraordinary that a number of non-botanist civilians, medical men and missionaries have materially added to our knowledge of plants. Several of them were not botanists in the formal sense, but were keen collectors with deep interest in plants

and development of Botany. They studied plants around them wherever they were stationed. Many of them are practically unknown now. It would be worthwhile recalling their memory here.

Dr. Alexander Gibson (1800-1807):

He first came to India as a vaccinator for Deccan and Khandesh. Because of his knowledge of plants he was appointed the Superintendent of the Botanical Gaiden of the East India Company at Dapodi near Pune, and was made later the first Conservator of Forests. He greatly added to the knowledge of the forest trees and forest practices, now followed all over India. He had intimate knowledge of villages and people and had a keen desire to improve their lives. He devoted the last few years of his service to the establishment of a well-known Forest Park and Botanical Garden at Hiwie in Junnar taluka in Pune district.

John Graham (1805-1839) :

He came to Bombay in 1828. He was Deputy Post Master at Bombay and wrote his famous *Catalogue of Bombay Plants* (1839). He died at Khandala in 1839.

Joseph Nimmo (1819-1854) :

He largely assisted Graham and completed his incomplete *Catalogue of Bombay Plants*, adding to it his own information. He was very generous in giving specimens to others. He was a friend of Wight, the author of '*Icones Plantarum*'. He was probably born in India.

Nicol Alexander Dalzell (1817-1878):

He came to India in 1847 with a degree in Medicine, but worked in the Customs Department at Bombay. He used to collect plants during leisure. He was persuaded by Gibson to join him, initially on a very small job in Forest Department, but by dint of his knowledge and hard work he rose to be the Chief Conservator of Forests, Bombay. For a long time, he was staying at Thane. He was working under Gibson, and published the first annotated Flora of Bombay in 1861, largely based on the identification of Graham's *Catalogue of Bombay Plants*. It is a better and improved version of Graham's 'Catalogue'.

Dr. J. E. Stocks (1822-1854) :

He was in the Bombay Medical Service, and being fond of plants, collected several species. Though he has not written formally, there are numerous references to his collections in Cooke's work. He largely collected in Sindh. He died prematurely. He supervised Victoria Gardens, Bombay, for some time.

Dr. William Gray (*1886*) .

Civilian of Bombay Government. He wrote the *Botany* of the Bombay Presidency in *Bombay Gaz.* Vol. **25**, Bombay.

Alexander K. Nairne :

There were other civilians like Johan Suderland Law (1818-1855) belonging to Medical or I. C. S. service who took keen interest in plant collection in the old Bombay State. References to their collections are made by Cooke at so many places in the '*Flora of the Bombay*

Presidency'. Some members belonging to Ecclesiastical service were also quite keen collectors, especially the Rev. Bishop R. D. Ackland and Alexander K. Nairne. Nairne belonged to the Bombay Civil Service and was stationed at Vengurla, Malvan as a Missionary. The book he had written was for the use of common man and students for knowing plants in their environment *viz.* "*The Flowering Plants of Western India*" (1895). It is written in popular style with descriptions and diagnosis in brief.

Alexander Gammie :

He was also a non-botanist, mainly an agriculturist. He had a flare for collection of plants and took keen interest in the development of the Ganeshkhind Botanical Garden at Kirkee (Pune). He was for a number of years Professor of Agriculture in the Agricultural College at Pune. He was an Economic Botanist. He took part in Brahmaputra Expedition and plantation of cinchona trees at Mungupoo.

Birdwood brothers :

Herbert Mills Birdwood (1837-1907) was a Justice at the Bombay High Court and was very much interested in making collections at Khandala Ghat, Matheran and Mahabaleshwar. He prepared a "*Catalogue of the Plants of Matheran and Mahabaleshwar*" of which two editions came out before he went back to England in 1868. His elder brother Sir George Birdwood (1832-1912), was Professor of Materia Medica in Grant Medical College in Bombay. He has written '*Catalogue of Economic Products of Bombay.*'

George Marshall Woodrow (1846-1911) :

He was a Professor of Botany at the Science College at Pune. He largely assisted Dr. Cooke in building the Poona herbarium which formed the basis of his flora and has written a book on the Gardening in Western India. He was helpful in building Agrihorticulturist Society's Garden at Pune (Empress Garden) and the Ganeshkhind Botanical Garden at Kirkee.

Alexander Talbot (1847-1917) :

He was the Chief Conservator of Forests. He arrived in India in 1875. He made intensive collections in North Kanara and his collections were brought to the Science College, and are now in the herbarium of the Western Circle of Botanical Survey of India at Pune, and some at the herbarium of the Southern Circle of the Botanical Survey of India at Coimbatore. Like Sedgewick and Saxton's collections his collections are remarkable for the details which he noted and the way they were mounted, and preserved. He was not only interested in angiosperms but also in ferns. He wrote two books *Forest Trees of Bombay*, a small handbook and his well-known illustrated work "*A Systematic List of the Trees, Shrubs and Woody Climbers of the Bombay Presidency*" (1894, 1909-1911). He had also made collections in Sindh and North Kanara.

Victor Jacquement (1801-1832) :

He was a Frenchman. He came to Pondicherry and went to Calcutta to learn Indian Plants. He learnt to recognise plants and their names. He also learnt Urdu, Persian and Pushtu. He collected plants in Kashmir valley by a special permission of the Maharaja Ranjit

Singh. He was a good collector, daring traveller, full of vitality and vigour. After his hectic tour of Kashmir he returned to Delhi and reached Pune and thence Salsette, Bombay, where he died in December 1832. His collection went to Paris. The description of his plants is included in a work *Plantae rariorae Asiaticae* (1844). His collections contained several plants from Pune, Bombay, Ghats, besides those of Kashmir. A blue flowered creeper is named after him as *Jacquemontia violecea* Choisy which is a fitting memorial to this illustrious Frenchman.

Rev. S. Hislop (1818-63) :

He came to India as a Scottish Protestant Presbyterian missionary and reached Nagpur in February 1845. The mission then used to run two educational institutes—Wilson College at Bombay and the Hislop College at Nagpur which was named after him. Though missionary by profession, he was deeply interested in Geology, Palaeontology and related subjects. While he was staying in mission's bungalow close to Takli near Nagpur, one day he came across a moluscan shell. He started searching animals and plants at various places in the Intertrappean bed at Takli. His interest took him to other places from where he discovered many Tertiary intertrappean plants and plants of *Glossopteris*, Flora of Mesozoic period at Kamathi like *Gangamopteris*, *Glossopteris Vertebraria*, *Noeggeriathiopsis*. He had trained a field collector by name Vira who obtained a fruiting inflorescence looking like that of Mulberry (*Morus*) or of an aroid. Sahni named this after him as *Viracarpon*. When further specimens were obtained by J. K. Verma, he named it as *Shuklanthus*. A part of Hislop's collection went to his home town and a part of it is preserved in the British Natural History Museum at London. The latter was studied by Sahni. He will be rated next to Feistmantel in the field of Palaeobotany and the first one to focus attention on the Tertiary Intertrappean flora of Nagpur. He has written a small book on "*Geology of Nagpur*." His death by accident in a flooded *nalla*, with his horse took place at Bori in Bor Nalla near Nagpur on 4th September 1863.

Theodore Cooke (1836-1910) :

He came to India at the age of 26 in 1862 as an Engineer to build railways. He was not only a well-trained engineer but a geologist also. He had a great interest in Geology and Botany. He was a man of extraordinary ability and was soon made the Principal of Engineering College, Pune. He stayed for nearly 28 years in Pune and was well-known to public as a scholar and helpful citizen. He was very fond of collecting plants around Pune, Bombay, Ghats and nearby areas, but due to the difficulties of not having railway and good roads, he could not collect plants from Konkan area. For information about the plants in Konkan he relied on Nairne, Talbot and Dalzell. He had also trained and employed excellent plant collectors like Bhiva, whom he often quotes in his *Flora of the Bombay Presidency*. He was assisted by Professor of Botany, C. M. Woodrow, at the Science College (now Engineering College), Bhide, Ranade, Kanitkar, Bhagwat and others. It was he who built the first herbarium at Pune. Talbot, Young presented their collections to him. He wanted to train forest officers in Botany, but the Central Government did not agree to his proposal. In 1890 the Botanical Survey of India was constituted with Sir George King as its head. Cooke suggested to him that the regional floras should be published, as they will be helpful to people. King did not approve his suggestion but appointed him as the First Honorary Director of the Botanical Survey of Western

India, assisted by a few local plant collectors and a herbarium keeper. His total grant was less than Rs. 2,000 per annum for all this labour of love. In 1890, he retired from service and left Pune and went to England. In 1893, the Government of Bombay commissioned him to write the *Flora of the Bombay Presidency*. This was the first regional flora brought out in the country. For this purpose he moved to Kew where the collections of Gibson, Dalzell, Graham, Nimmo, Ritchie were housed. Till that time the only work on the flora of Bombay was the *Catalogue of Bombay Plants* by Graham, Dalzell and Gibson's *Flora of Bombay and its vicinity* and Nairne's *Flowering Plants of Western India*. While he was working at Kew on the Bombay plants, an unfortunate thing happened. The whole collection comprising 1400 species and 5000 specimens were completely destroyed by fire in the Engineering College. While going to England, he had taken several sets of plants of Bombay Presidency with him and from his personal set he sent to Pune herbarium again a complete set of Bombay Plants. But as Puri (1959) has pointed out several of the types in it are not there. The herbarium now stands at a fairly high level having more than a lakh of herbarium specimens. The publication of Cooke's Flora continued from 1901 to 1908. It also contains the account of plants of Sind, Gujarat, Baroda, Sawantwadi and North Kanara. These, except Sawantwadi, are no longer parts of this State. In his account 2509 species with 147 varieties and 1003 genera belonging to 147 families are described. Many later workers like G. B. Patwardhan, H. P. Paranjapye, S. R. Godbole, and W. Burns have added to them and the present number of collection is pretty high, over a lakh.

R. K. Bhide :

Among the early collectors, a special mention deserves to be made of R. K. Bhide who was herbarium assistant to the Professor of Botany, first at the College of Science and later College of Agriculture, Pune. His great mastery over the details of grasses was utilized by Blatter and McCann who wrote a large treatise on the *Grasses of Bombay* (1935). It is still a monumental work fully illustrated by R. K. Bhide.

Bhiva :

He was a plant collector of Dr. Cooke, trained by the latter. Numerous references to him in the Cooke's *Flora of Bombay* testify to the zeal, great interest and precision with which Bhiva made collections at a number of places.

Besides these, several other botanists like Dr. Sakharam Arjun Raut, Col. Dymock, Dr. Gadgil working in the pharmacology department of the Grant Medical College, Bombay, Professors Hate and Ezakiel of the Wilson College, R. N. Dastur, a well-known Plant Physiologist then at the Royal Institute of Science, Prof. J. T. R. d'Almeida and D. P. Mulla working at St. Xavier's College, B. S. Nawalkar, who worked on mangroves at the Royal Institute of Science, Bombay, all have contributed to the understanding of plants of Western India. Mr. Charles McCann had worked as the keeper of herbarium at the Prince of Wales Museum, and had voluminous collections of Bombay plants. In collaboration with Fr. Blatter he has published many contributions to the botany of Western India. He left India for New Zealand and was working at the National Museum at Wellington, New Zealand.

It is necessary to know further some very distinguished botanists of Western India.

Three noteworthy Indian associates of Van Rheede in writing *Hortus Indicus Malabaricus*:

They are Ranga Bhatt, Appu Bhatt and Vinayak Pandit. Van Rheede was the Dutch Military Commandant with the Governor of Malabar. He commissioned these three learned men in Ayurveda to write truthfully on the properties of drug-yielding and other plants, on oath of their family deity. They took the oath, each in his mother tongue printed in *Hortus Indicus Malabaricus.* They have given the description and illustrations and the local names of plants of Western India in their own languages and in script. The illustrations were drawn by artists and are quite good. Linnaeus, the great, had adopted their names as such in his binomial system of nomenclature in his "*Species Plantarum*" for Indian Plants. Their writings were translated into Latin and published by Van Rheede in Amsterdam between 1678-1703 in twelve large volumes. They are really the co-authors of this work and have made the Indian Plants famous all over Europe.

Dr. Celasio Dalgado:

He was a graduate in Medicine but was much attracted to Botany and Horticulture. He was employed in the service of the late Maharaja of Sawantwadi as the Civil Surgeon of the State. He started cultivation of cocoa and spices in Sawantwadi where the climate is suitable for them. He is the author of a useful book written in Portuguese, *The Flora of Goa and Sawantwadi,* published in 1898. He introduced a number of plants in that State from other parts of India, and especially from Sri Lanka. He died in Lisbon after 1898.

Colonel K. R. Kirtikar (1850-1917):

He belonged to the Indian Medical Service and saw active service in the Indo-Afghanisthan War (1880). He was Surgeon General with the Government of Bombay and is author of a number of articles on plants of Western India. He published them in the Bombay Natural History Society's Journal, in the development of which he took prominent part. His book on the '*Poisonous Plants of Bombay*' is well-known. His other work with Dr. K. P. Basu, '*Medicinal Plants of India*' is a fine reference work with illustrations (1918).

Dr. J. C. Lisboa (—1898):

Dr. Lisboa was Professor of Pharmacology in the Grant Medical College, Bombay. His interest was mainly in grasses. His large collections of grasses are in the herbarium at the Grant Medical College, Bombay Natural History Society, and some in Blatter Herbarium, St. X'avier's College, Bombay. He has published articles on the grasses of Bombay. A prize in his name called 'Lisboa Prize' and a scholarship at the graduate level is awarded every alternate year by the University of Bombay for practical Systematic Botany.

Jaikrishna Indraji Thakar (1849-1930):

Jaikrishna Indraji was born at Lakpat in Saurashtra in October 1849. He served as the Curator of Forests and Parks in Porbander and as Treasury Officer till 1904, and after retirement was employed in Cutch State as the Superintendent of Palace Gardens at Bhuj. Being much interested in plants and research he collected plants of Barda Hills in Saurashtra and wrote a comprehensive account in Gujarati in a book entitled *Kathiawadna Barda Dungarni Jadi Buti, Teni Pariksha ane Upayoga*

(1910) (Botany and Comprehensive account of the Flora of Barda mountains, Kathiawar). He wrote another book in Gujarati *Cutch Sansthanani Vanaspatio Ane Tene Upayogita* (1926). These are the only books on flora, written in any Indian language. His earlier book on the Flora of Barda Mountains is now revised by Shri Bapalal Vaidya of Surat, published by Sastu Sahitya Vardhak Karyalaya, Ahmedabad.

His collection of plants is now kept in the herbarium of the Western Circle of Botanical Survey of India at Pune. He trained many Ayurvedic Physicians in the identification and classification of plants. His tradition was kept up by Gokuldas Bambdai who also has published a book on *The Plant World of Kutch* (in Gujarati) and by Shri Bapalal Vaidya whose several works on Indian Drug Plants in Hindi and Gujarati are well-known.

W. J. Sedgewick :

He was an ICS Officer. He has made collections of grasses and added materially to the collection in the herbarium of the Western India. He is the co-author of a book called *Flora of Northern Gujarat* with W. T. Saxton, Professor of Botany at Gujarat College, Ahmedabad (1918). He got all his specimens identified and authenticated at Kew Herbarium. They are so nicely preserved that even today they are a model for the preparation of the herbarium sheets. They are in Botany Department, Gujarat College, Ahmedabad.

Rev. Father Ethalbert Blatter, S. J. (1877-1934) :

Father Blatter was born in Switzerland on 15-12-1877 and joined the Society of Jesus in 1896. He came to St. Xavier's College, Bombay in 1903 as Professor of Biology and went back to Europe for studying various subjects. He returned to Bombay in 1915 and became the Principal of St. Xavier's College from 1921 till a few years before his death. He wrote several articles for the revision of Flora of Bombay and completed several of his works, such as *Bombay Grasses*. He knew several European languages and was adept in Western Music.

He trained many students in taxonomy and has written a very large number of papers, nearly 300. He was a great explorer of plants from Himalayas to High Wavy Mountains. He and J. F. R. Almeida have written a book on the *Ferns of Bombay* and a large treatise on the *Palms of India and Ceylon* (1926). He knew equally well Geology and Zoology and was fond of studying snakes. He was President of the Indian Botanical Society, Indian Science Congress and Bombay Natural History Society. He has contributed more than 200 papers in the Society's Journal.

He died at Pune on 26th May 1934. He was almost like an Encyclopaedia of Knowledge on plants, not only of Kashmir and Vaziristan and Western Ghats, but of the whole of India. He made intensive collections with detailed notes of their habitats and variations. His tradition was rightly kept up by his students like Professor S. P. Agharkar, D. L. Dixit, R. H. Dastur, M. A. Moghe, Charles McCann, J. F. R. d'Almeida and Father Santapau. All his collections are housed in Blatter Herbarium at St. Xavier's College, Bombay.

Prof. D. L. Dixit (1869-1948) :

He was Professor of Botany at the Fergusson College. He started studies on the vascular cryptograms in Western India. He was a well

trained systematic botanist and is the author of a small but extremely useful book *Natural Orders of Angiosperms of Western India.*

Prof. J. F. R. d'Almeida (1889-1949):

He was born at Bandra on 24-10-1889. He was a pet student of Father Blatter, and later Professor of Botany at St. Xavier's College, Bombay. He was a great master of systematic botany and anatomy and knew every plant in the vicinity of Bombay. He was also a good connoisseur of ferns and had worked on Indian *Ophioglossums.* He has published with Blatter a book on the Ferns of Bombay. In him, Botany and social service were combined in a unique way. He died at Bandra on 7th May 1949.

Prof. S. L. Ajrekar (1883-1954):

He was Professor of Mycology and Plant Pathology at the College of Agriculture, Pune. He started the School of Mycology not only in Pune but also in other places in the country. He was a distinguished student of the Wilson College, Bombay and had secured Mangaldas Nathubhai Scholarship for studying abroad on some applied branch of Botany. He went to Cambridge and studied mycology and plant pathology in the School of the most distinguished mycologist of England, Prof. Marshall Ward. He is the author of several articles on Botany in Marathi in *Shrishtidnyan* and *Dnyankosh* and has contributed several papers in English on the Fungi of Bombay. He trained a number of research students in the study of Mycology. He was Professor of Botany at the Royal Institute of Science, Bombay, and was required to go to Ahmedabad for organizing the newly started Botany Department at the Gujarat College, Ahmedabad, from where he retired in 1938.

Dr. W. Burns:

He was the Principal of the College of Agriculture, Pune and was a trained geneticist. He trained a number of young workers in the study of plant genetics at the College of Agriculture. He started the school of studies in ecology of grasslands in arid regions of India, especially around Pune.

Prof. R. H. Dastur:

He was the Professor of Botany at the Royal Institute of Science, Bombay, and later Plant Physiologist with the Central Cotton Committee. He was a well-known plant physiologist and has published a number of papers on the physiology of rice, cotton wilt, and on photosynthesis.

Prof. S. P. Agharkar (1884-1960):

Professor S. P. Agharkar was born at Malvan on 18th November 1884 Prof. Agharkar had matriculated from the Government High School, Dharwar. He knew Kannada well. He took his B. A. degree in First Class from Elphinstone College, Bombay in 1902 with Botany, Geology and Zoology as optional subjects. He was awarded Bell prize for proficiency in English at B. A. He got Lisboa Scholarship for Practical Botany in 1907. He took his M. A. degree in Biological Sciences in 1909 and started teaching at Elphinstone College. Under the influence of Father Blatter he developed keen interest in plant and animal exploration and collection, and explored the Western Ghats. He got a fresh water medusa at Tambi in Koyna, Venna and Krishna rivers later named *Limnocnida indica* by Annandale. This caught the attention of Sir Wright W. Smith, F. R. S., Superintendent of the Royal Botanical

Garden, Calcutta. At the suggestion of Sir C. V. Raman he was appointed by Sir Ashutosh Mukerjee to the Chair of Ghosh Professor of Botany. To obtain advanced knowledge in Taxonomy of plants he went to Germany on 2nd May 1914, but I World War soon broke out, and as an enemy subject he was interned in various German Camps from October 1914 to June 1917. Even during internment he used to collect and study plants. After the cessation of hostilities he was privileged to study botany in Berlin under the distinguished German Professors Engler, Diels, Pilger, Lindau and several others. At the end of two years he presented a thesis entitled *Verbreitungsmittel der xerophyten und sub-xerophyten des Nordwestlichen Indiens und ihr Herkunft*, which was considered "very laudable" by Engler and Heberlandt. After getting the Ph. D. degree he visited a number of countries in Europe and returned to India and, started teaching Systematic Botany, Plant Geography, Gymnosperms, and Genetics at Calcutta University. He explored the flora of Nepal. He organized the Botany Department of Calcutta University on a large scale, where several disciplines were equally well-developed. His interest was varied, in Angiosperms, Water plants, Bengal plants, origin and composition of plants in Indian desert etc. By dint of his devotion, integrity and hard work he became the Secretary and Treasurer of several bodies such as Indian Botanical Society, Royal Asiatic Society of Bengal, National Institute of Sciences of India and a member of several committees appointed by the Government. A special mention must be made of his appointment as Chairman of the National Herbarium Committee which ultimately resulted in the revival of the Botanical Survey of India in 1950. All these numerous extramural activities made large inroads on his time and energy. On 7th October 1944, with Dr. M. R. Jayakar, Principal Gharpure of Law College, Pune and fellow botanists like Professor S. L. Ajrekar, and N. V. Joshi he started the Maharashtra Association for the Cultivation of Science. This has now developed into a first class research institute. Afterwards he developed cancer and was operated for it in August 1956 and succumbed to the disease on 2nd September 1960 nearly after five years of operation. His inaugural contribution in German for Ph. D. degree on to the arid and semi-arid plants of North Western Frontier Province and their means of dispersal is a very valuable paper. His account of History of Botany in 1938 is famous. His work on Medicinal Plants, Timbers and Miscellaneous Plants published in three volumes of the *Gazetteer of Bombay State*, published by the Gazetteers Department are a spectacular contribution to knowledge.

Father H. Santapau (1903-1970):

Dr. H. Santapau, Professor of Botany at the St. Xavier's College, Bombay was born in Spain on 5th December 1903. Prior to his joining St. Xavier's College he had studied at Rome and London from where he got his doctorate on the *Flora of Khandala*. For this he had examined all the plant material of the Bombay Presidency at Kew Herbarium. He joined the Botanical Survey of India as its Director and reorganised the work of the Survey. He got reprinted the regional floras of various States. He also reorganised the Indian National Herbarium at Calcutta and Botany section of the Indian Museum, Calcutta. He did a yeoman's service to the cause of systematic botany of Western India and the whole of India. He led a team of botanists to tour and to collect material in U. S. S. R. in 1962. Though Spanish by birth he had accepted Indian citizenship. He died at Bombay on 13th January 1970. He has published numerous papers on the taxonomy of Indian Plants, but he is very well-known for his books "*Flora of Khandala*" and "*Flora of Purandar*" They are a model for workers in taxonomy.

H. P. Paranjapye (1879-1977) :

He was born at Murdi near Anjarle in Ratnagiri. He graduated in Natural Sciences in 1905 from Fergusson College, Pune and worked in the herbarium of the Economic Botanist at the College of Agriculture under famous British botanists like Dr. Gammie, Dr. Harold Mann, Dr. Burns etc. He tried to conserve rare botanical plants planted by early British botanists at Ganeshkhind Botanical Garden, Pune, and re-arranged the whole botanical garden. He conserved some mango trees that were planted in the days of Peshwas. His book in Marathi (आमची फळबाग) is very popular and has run into three editions. After the first World War he was sent to Mesopotaemia to bring new varieties of citrus, grapes and figs. Soon after he was made the Chief of the Ganeshkhind Botanical Garden and Professor of Economic, Botany and Horticulture at the College of Agriculture, Pune. He has written a number of articles on farming. He was the Secretary of Maharashtra Association for the Cultivation of Science for a number of years.

Madhav Narayan Kamat (1897 –1980) :

Prof. Madhav Narayan Kamat was one of the most distinguished Mycologists and Plant Pathologists of India. Born at Ubhadanda in Ratnagiri district on 5-5-1897, he was educated at Kumata in North Kanara district, and at College of Agriculture, Pune. He graduated in 1919 from that College and took M.Sc. degree working under Prof. Stakman at Minnesota University in U.S.A. in 1932, and joined the College of Agriculture, Pune as Assistant Professor of Mycology and Plant Pathology. Here he taught and worked for 30 years and was in charge of various schemes dealing with genesis and control of *Kole Roga* of betel-nut, Mildew of betel vine, Gummosis of citrus, Corn Rust of jowar, and various other plant diseases.

By vast experience, he was almost like a Dictionary of Mycology and Plant Pathology. He has published 350 research papers and guided research work of 30 students. With Prof. S. P. Agharkar and Prof. S. L. Ajrekar, he was instrumental in building the Maharashtra Association for the Cultivation of Science at Pune. In view of his contribution and books on the subject, the Mahatma Phule Krishi Vidyapeeth (Agricultural University) at Rahuri awarded him D.Sc. Degree. He was elected President of the All India Phytopathological Society in 1975. After a short illness he expired at Pune on 3rd December 1980.

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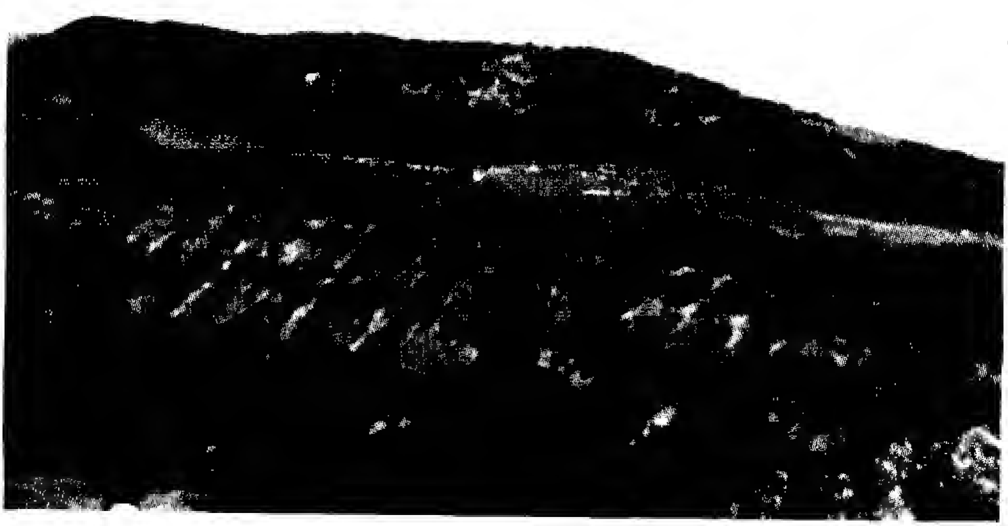
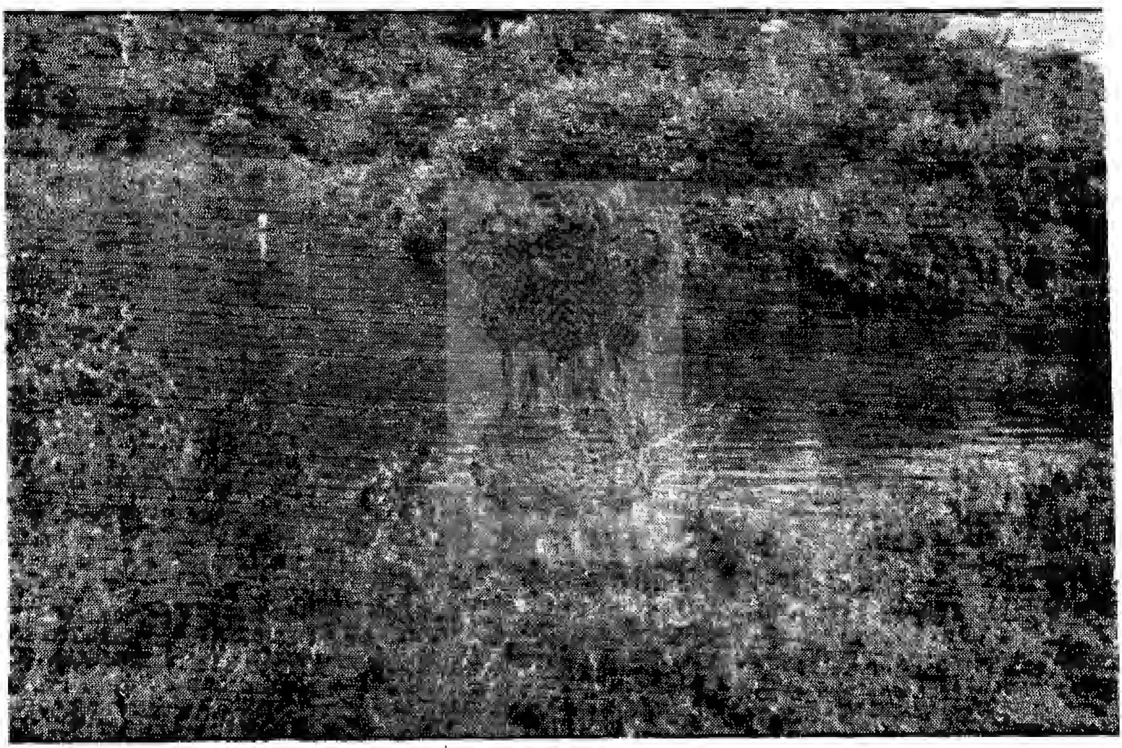
Mahabaleshwar Ghat

Amboli Ghat, Sawantwadi



Mangroves Vegetation at Mumbra



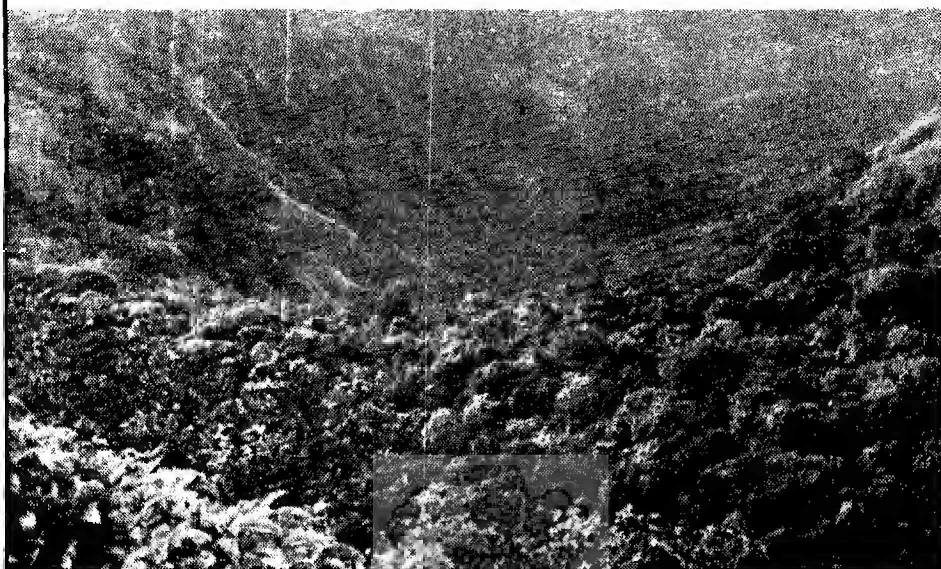
Swampy Mangroves Vegetation near Thane Creek

Evergreen Forest, Radhanagari

Teak Dry Deciduous Forest, North Chandrapur

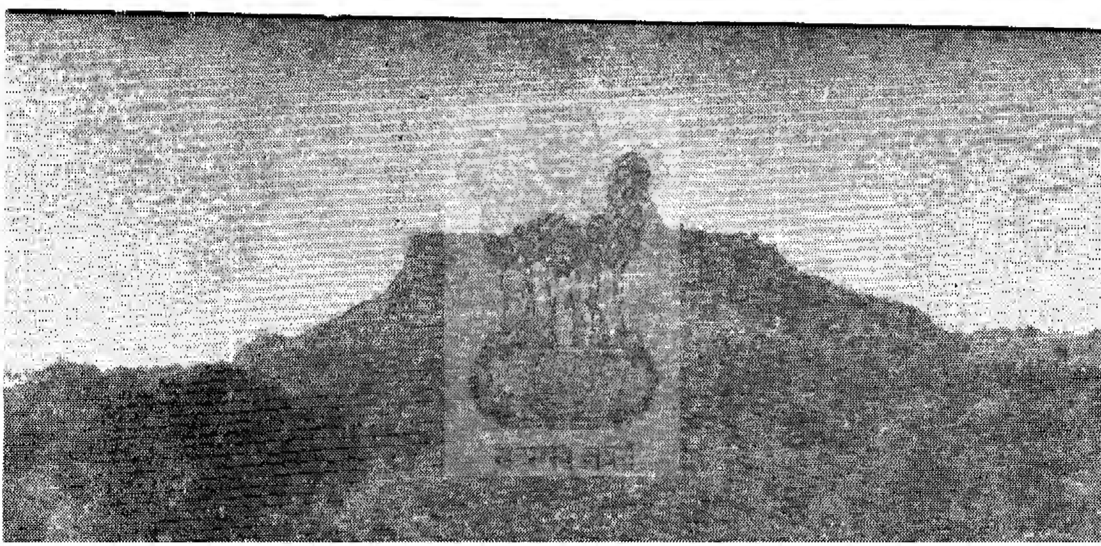
Southern Tropical Thorny Forest near Daund (Pune)

Radhanagari Forest

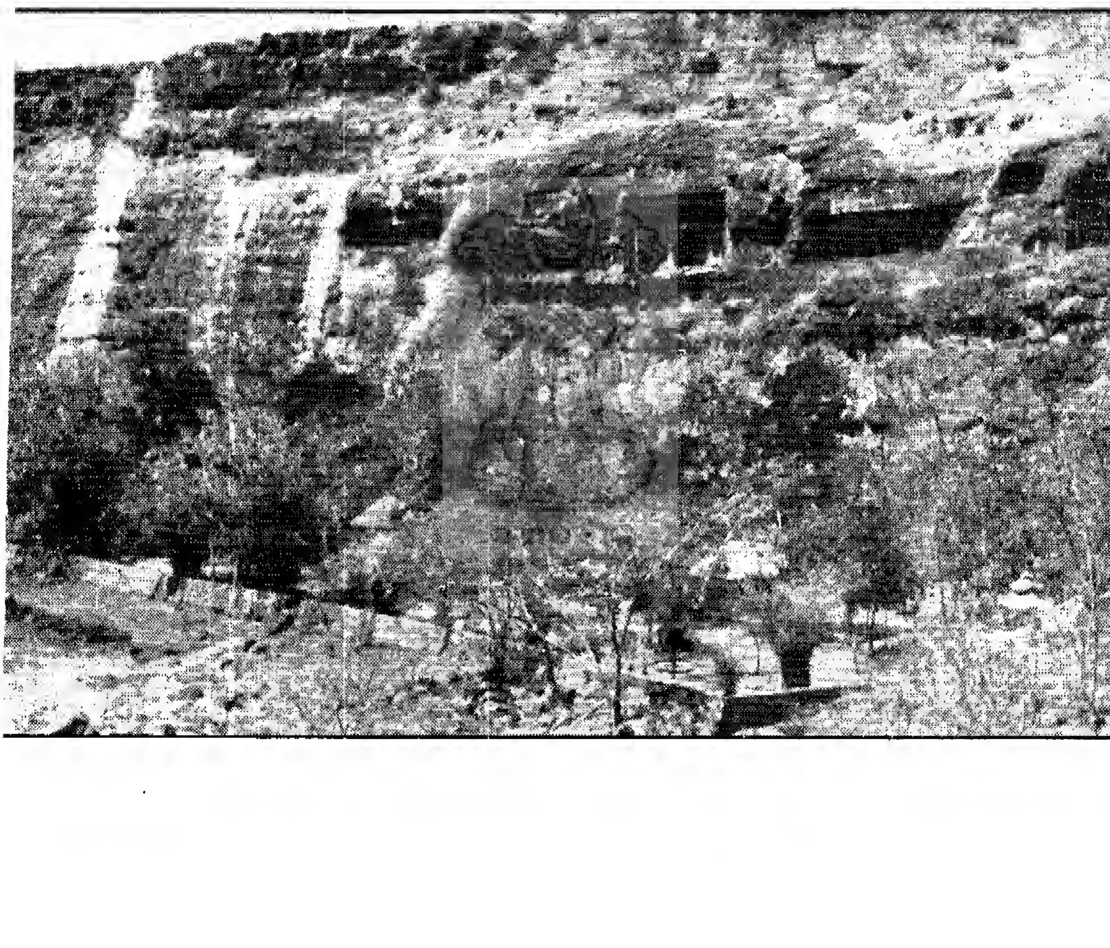


Nagzira Pench Forest

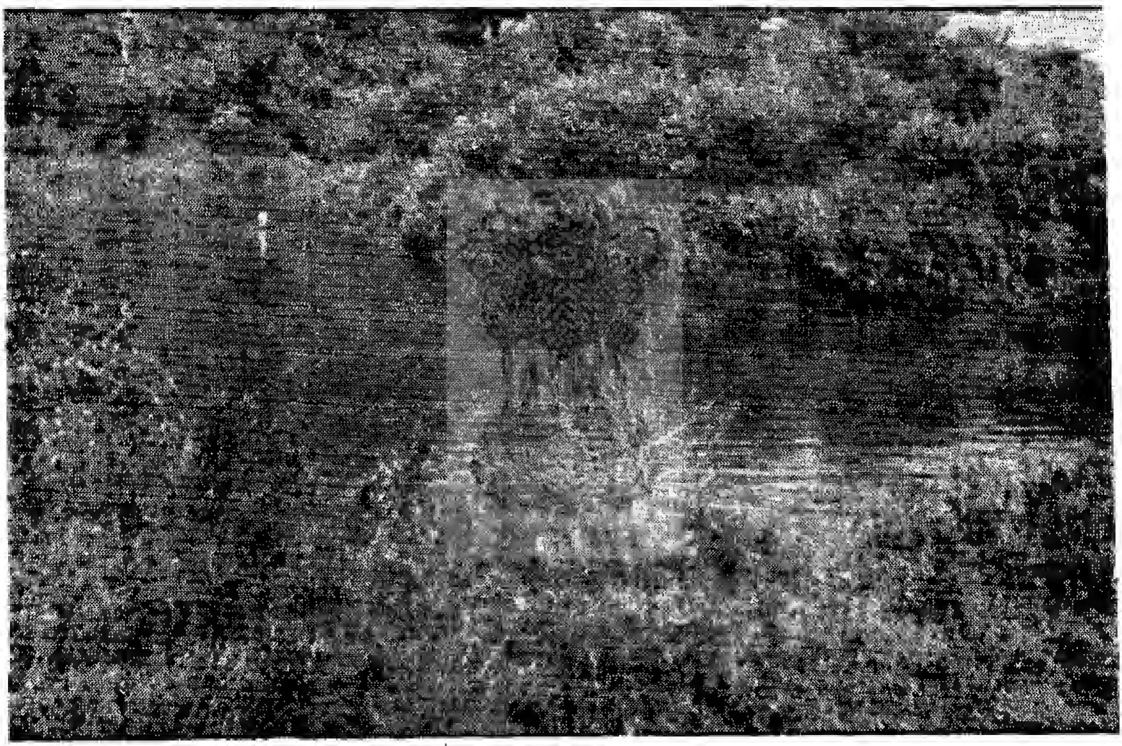
Karnala Forest



Flora around Ajantha Caves

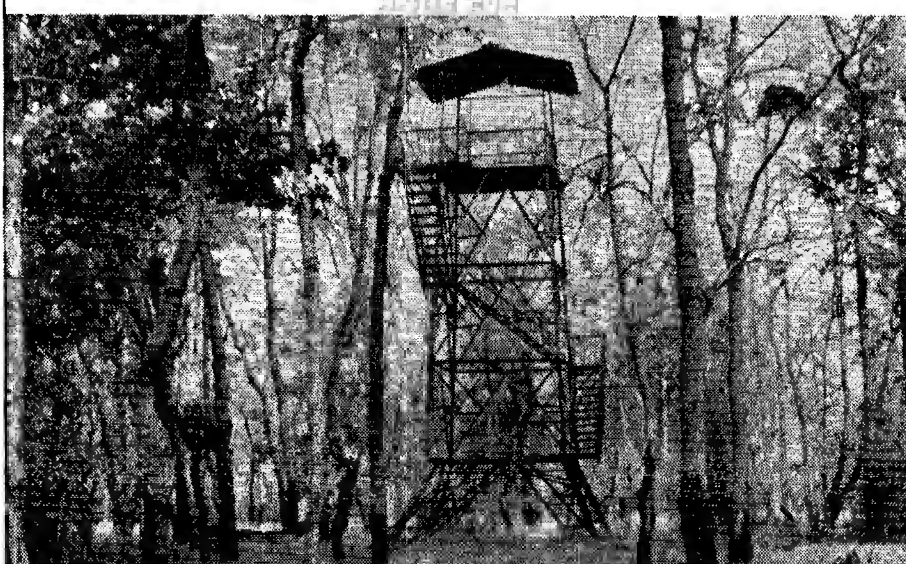


Mangroves Vegetation at Mumbra



Chandrapur Flora (Tadoba)

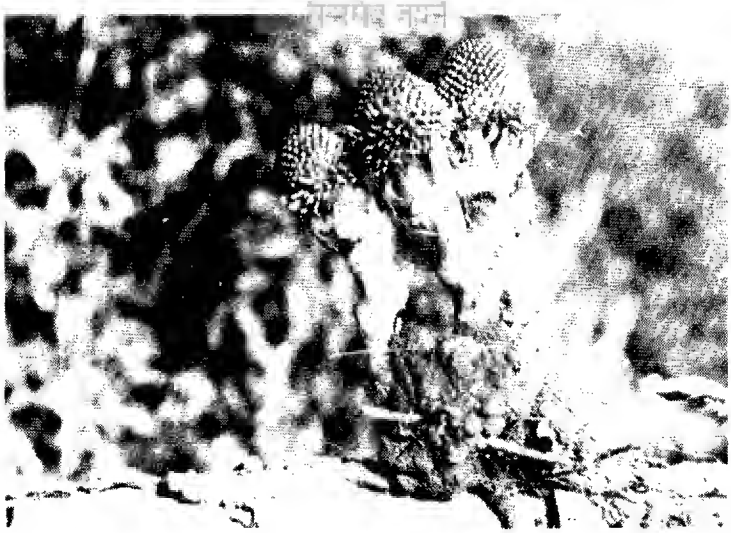
Forest Tower, Tadoba



Mahabaleshwar Flora

Koyna Catchments Flora

Orchid Epiphytic



Root Parasite